NOAA Technical Report NMFS SSRF-701

Seasonal Abundance and Distribution of Zooplankton, Fish Eggs, and Fish Larvae in the Eastern Gulf of Mexico, 1972-74

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SEATTLE, WA
AUGUST 1976

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Seasonal Abundance and Distribution of Zooplankton, Fish Eggs, and Fish Larvae in the Eastern Gulf of Mexico, 1972-74[1]

EDWARD D. HOUDE and NICHOLAS CHITTY[2]

ABSTRACT

Zooplankton volumes and abundance of fish eggs and fish larvae were determined for stations on 12 cruises to the western Florida continental shelf. Contour charts of zooplankton volumes and of ichthyoplankton abundance are presented. A marked seasonality was observed for zooplankton and ichthyoplankton, highest zooplankton volumes and ichthyoplankton abundance occurring during May through September. Zooplankton volumes were highest and spawning by fishes most intense in the northern half of the study area (north of lat. 27°15′N). Fish larvae abundance (number under 10 m^2 of sea surface) was highest at stations deeper than 50 m. Simple correlations among biological variables showed fish egg abundance-zooplankton volumes and fish egg abundance-fish larvae abundance to be positively correlated on most cruises. No clear relationships were observed between abundance or concentration of biological variables and temperature or salinity.

INTRODUCTION

A fisheries assessment survey of sardinelike fishes in tern Gulf of Mexico was carried out from 1971 to 1974 nate spawning biomass from the seasonal abundance nd tribution of planktonic eggs and larvae (Houde 1973, 974, in press). A total of 12 cruises was completed during 972-74 from which both plankton samples and hydrographic ere collected. Zooplankton abundance and the abundance of both fish eggs and fish larvae were examined to determine which areas of the western Florida continental shelf Fig. 1) were highly productive with respect to plankton and areas might be important spawning areas for fishes. ance of these organisms was examined seasonally and n relation to temperature and salinity in the eastern Gulf.

Most previous reports on plankton abundance from the n Florida shelf area included few sampling stations or ot carried out long enough to determine seasonality of roduction. Hopkins (1973) recently has reviewed plankton nvestigations in the eastern Gulf. Plankton abundance from aters on a transect west of Charlotte Harbor (lat. N) in 1946-47 was reported by King (1949). Arnold 1958) summarized results of plankton-ichthyoplankton collections made throughout the Gulf of Mexico in 1951-53. His ons included 63 stations from the western Florida that were sampled quantitatively. Soviet-Cuban ishery investigations in 1963-64 included some determinaions of total plankton biomass from most parts of the Gulf of . These data were summarized by Bogdanov et al. and Khromov (1969). Recently, Austin and Jones 1974) reported on the physical oceanography and plankton iomass relationship on the Florida Middle Ground, a tive shelf area located northwest of Tampa Bay. data represented monthly observations from June 969 through August 1970 and included a single fixed station t lat. 28°30′N, long. 84°14′W, as well as three to five stations on a transect along lat. 28°30′N. Although earlier reports are incomplete in many respects, and sometimes incomparable due to collecting gear differences, they do offer a basis for comparison with our plankton distribution data which give more complete seasonal and areal coverage of the eastern Gulf.

Identification of organisms was limited to the broad categories of zooplankton, fish eggs, and fish larvae. Thus, our results were used only in a relative sense, to define areas of high or low productivity on the western Florida shelf. The eggs and larvae of clupeid fishes were identified and future papers will describe their distribution and abundance, as well as estimates of stock abundance based on them (Houde in press). Results published here will be useful when considering possible effects of man's activities in the

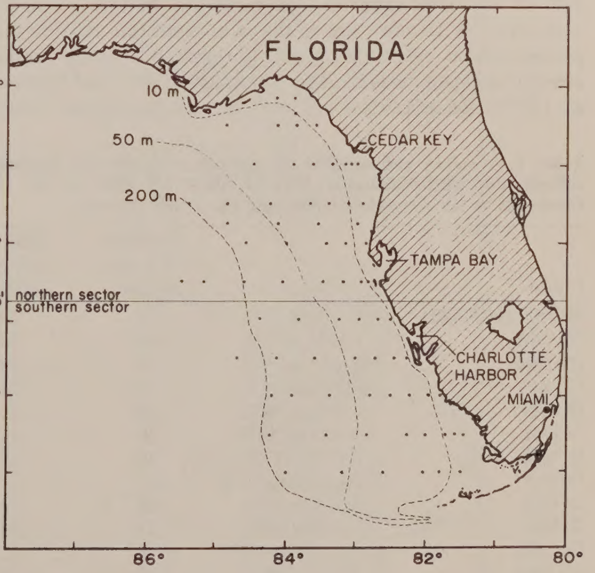

Figure 1.—Chart of eastern Gulf of Mexico ichthyoplankton survey area. Dots indicate stations.

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tribution from the Rosenstiel School of Marine and Atmospheric cience, University of Miami, Miami, FL 33149.

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eastern Gulf of Mexico, because the area has important commercial fisheries and is presently a focus of oil exploration.

METHODS

Data based on 12 cruises during 1972-74 are included in this report (Table 1). Plankton volumes were determined from a total of 482 stations and fish eggs and larvae were collected at 483 stations. Stations were located on a grid extending from lat. 24°30′N to lat. 29°30′N and from the 10-m contour near the west Florida coast to approximately the 200-m contour at the edge of the continental shelf (Fig. 1). The two cruises in 1974 included some stations in water as shallow as 4 m to compare plankton biomass and fish spawning there with offshore areas. The number of stations occupied on cruises ranged from 13 to 51 (Table 1).

Plankton collections were made with the paired 61 cm Bongo net plankton sampler (Posgay et al. 1968). One net was fitted with 505-μm Nitex mesh from which fish eggs and larvae were sorted. The second net was 333-μm Nitex mesh and it was used to provide zooplankton for volume determinations; this net meets the specifications of a reference net prescribed by the National Academy of Sciences (1969) for determining zooplankton biomass. A TSK (Tsurumi-Seiki Kosakusho) flowmeter was secured in the mouth of the 505-μm mesh net to determine volume filtered during each tow. Tows were double oblique from within 5 m of bottom to surface, or from 200-m depth to surface at deep stations. Towing speed was 2 to 3 knots and winch speeds were controlled to ensure that all depths were sampled proportionately. A Benthos time-depth recorder was attached to the plankton sampler to record tow characteristics. Tow times varied from 1 min at stations shallower than 50 m to 20 min at the deepest stations. Volumes filtered during a tow varied from approximately 100 m^3 at shallow stations to 400 m^3 at the deepest stations.

All plankton collected by the nets was retained and preserved in 10% buffered seawater Formalin. In the laboratory all fish eggs and larvae were sorted from the 505-μm mesh net samples. After samples had been stored for at least 2 mo to allow for changes in plankton volume due to preservation, volumes were determined using methods similar to those described by Thrailkill (1969) and Kramer et al. (1972). Zooplankton volumes are displacement volumes, reported as cubic centimeters per 1,000 m^3 of seaw filtered by the collecting net. Contour charts (Fig illustrate zooplankton concentrations for each cruise. are mean values for the whole water column at a lo since discrete depth strata were not sampled.

Table 1.—Cruises and number of stations analyzed for zooplankton volumes and ichthyoplankton, 1972-74. 8B = RV *Bellows*, **GE =** RV *Gerda*, **IS =** RV *Columbus Iselin*, **and CL =** RV *Calanus*.

Cruise	Dates	Plankton volume stations	Fish egg and larvae stations
8B 7201 & GE 7202	1-11 Feb. 1972	26	30
GE 7208	1-10 May 1972	28	30
GE 7210	12-18 June 1972	13	13
IS 7205	9-17 Sept. 1972	34	34
IS 7209	8-16 Nov. 1972	49	50
IS 7303	19-27 Jan. 1973	50	51
IS 7308	9-17 May 1973	49	49
IS 7311	27 June-6 July 1973	51	51
IS 7313	3-13 Aug. 1973	50	50
IS 7320	6-14 Nov. 1973	51	51
CL 7405	28 Feb.-9 Mar. 1974	36	32
CL 7412	1-9 May 1974	45	42
Totals		482	483

Zooplankton displacement volumes were determ after removing nonplanktonic organisms (e.g., sea large fish) and large planktonic organisms (> 5 cc; coelenterates). The remaining zooplankton organisms of 5 cc or less in volume. This fraction of the plan sampled was aspirated onto a 35-μm plankton mesh f a Buchner funnel under a 22 psi vacuum until less th drop of water per 15 s was drawn from the sample. S with large numbers of jellylike organisms were aspirate shorter times to avoid reduction in plankton volume body fluid loss. Volume was then determined by displacement in a graduated cylinder. The zoopl volumes given in this report, therefore, are for organ less than 5 cc. The most numerous organisms were ceans, molluscs, and chaetognaths, all of which are tant in food webs that sustain pelagic fish resources

Numbers of fish eggs and larvae were reporte numbers under 10 m^2 of sea surface, giving an esti abundance for each station. Contour charts of the abu of fish eggs and larvae (Figs. 3, 4) show the distr based on this method. Mean concentrations of fish eggs larvae at a station also can provide useful information. values are not illustrated or reported here but obtained from our abundance charts and a bathymetri of the eastern Gulf by multiplying our contoured abund values by 10/d (where d equals depth of tow in met give numbers per 100 m^3. Tow depths and volumes for stations on each cruise are available in a compre data report (Houde et al. 1976). If calculated, concentra of fish eggs or larvae at a given station represent th concentration over the tow depth of that station discrete depths were not sampled.

Contour charts for zooplankton, fish eggs, and larvae were produced using the method propos Simpson (1959). Isopleths of zooplankton concent were drawn for the 25, 50, 100, 400, and 800 cc/1,000 tours (Fig. 2). Those for fish eggs and larvae were draw 50, 100, 400, 800, and 1,600 under 10 m^2 of sea surfac 3, 4).

Temperatures and salinities were obtained at ea tion by casts of 1.7 liter Niskin bottles equipped reversing thermometers. A mechanical bathytherm also was dropped at each station. An STD (salinity-t ature-depth) recorder was used on some cruises. Sa from Niskin bottle samples were determined on a sal bridge.

Analyses of hydrographic data and contour p these data were provided us by physical oceanograp the State University System of Florida Institute of Oc ography and the Rosenstiel School of Marine and A spheric Science.[3, 4]

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[3] State University System of Florida, Institute of Oceanograph Petersburg, Fla. 1975. Final Report to Bureau of Land Manage Contract No. 08550-CT4-16. Compilation and summation of histo existing physical oceanographic data from the eastern Gulf of M p. plus 7 appendices.

[4] Hydrographic data from cruises discussed in our repor available through the National Oceanographic Data Center, Washin D. C. Data can be retrieved from the MAFLA (Mississippi-A Florida) file.

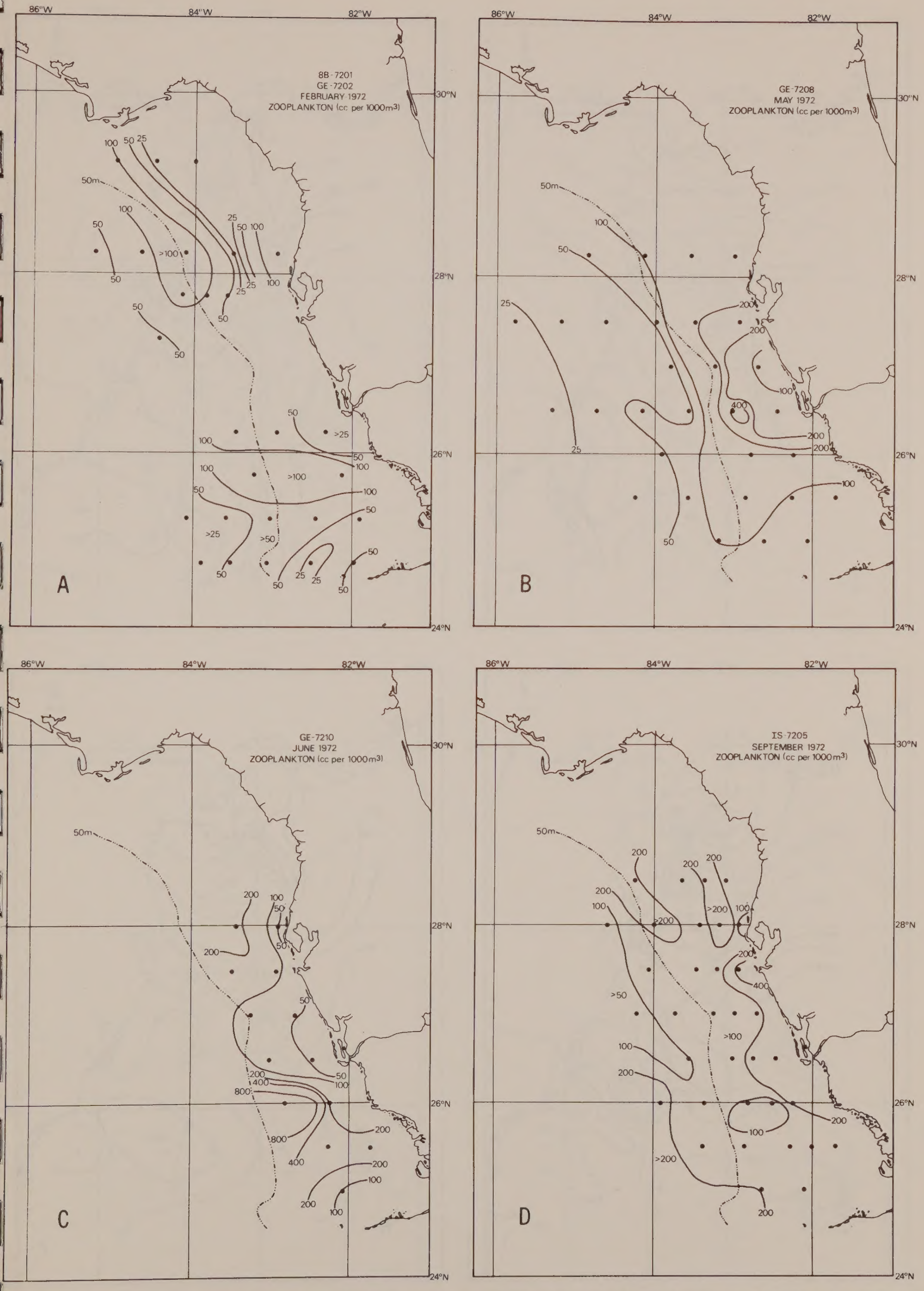

86°W
84°W
82°W
30°N
28°N
26°N
24°N
8B-7201
GE-7202
FEBRUARY 1972
ZOOPLANKTON (cc per 1000m3)
50m
A
GE-7208
MAY 1972
ZOOPLANKTON (cc per 1000m3)
B
GE-7210
JUNE 1972
ZOOPLANKTON (cc per 1000m3)
C
IS-7205
SEPTEMBER 1972
ZOOPLANKTON (cc per 1000m3)
D

Figure 2.—Contour charts of zooplankton volumes (cubic centimeters per 1,000 m³) for 12 cruises in the eastern Gulf of Mexico, 1972-74.

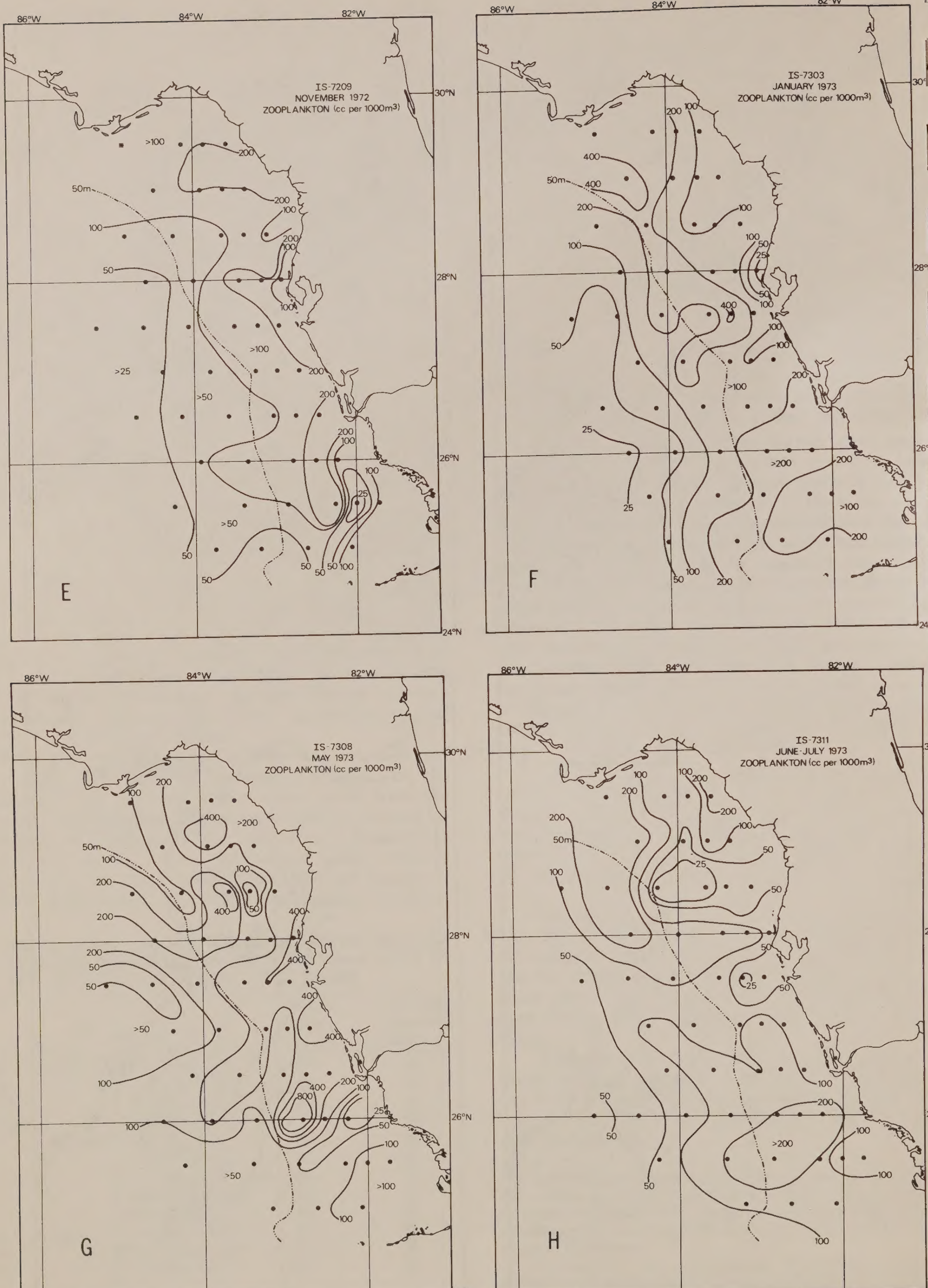
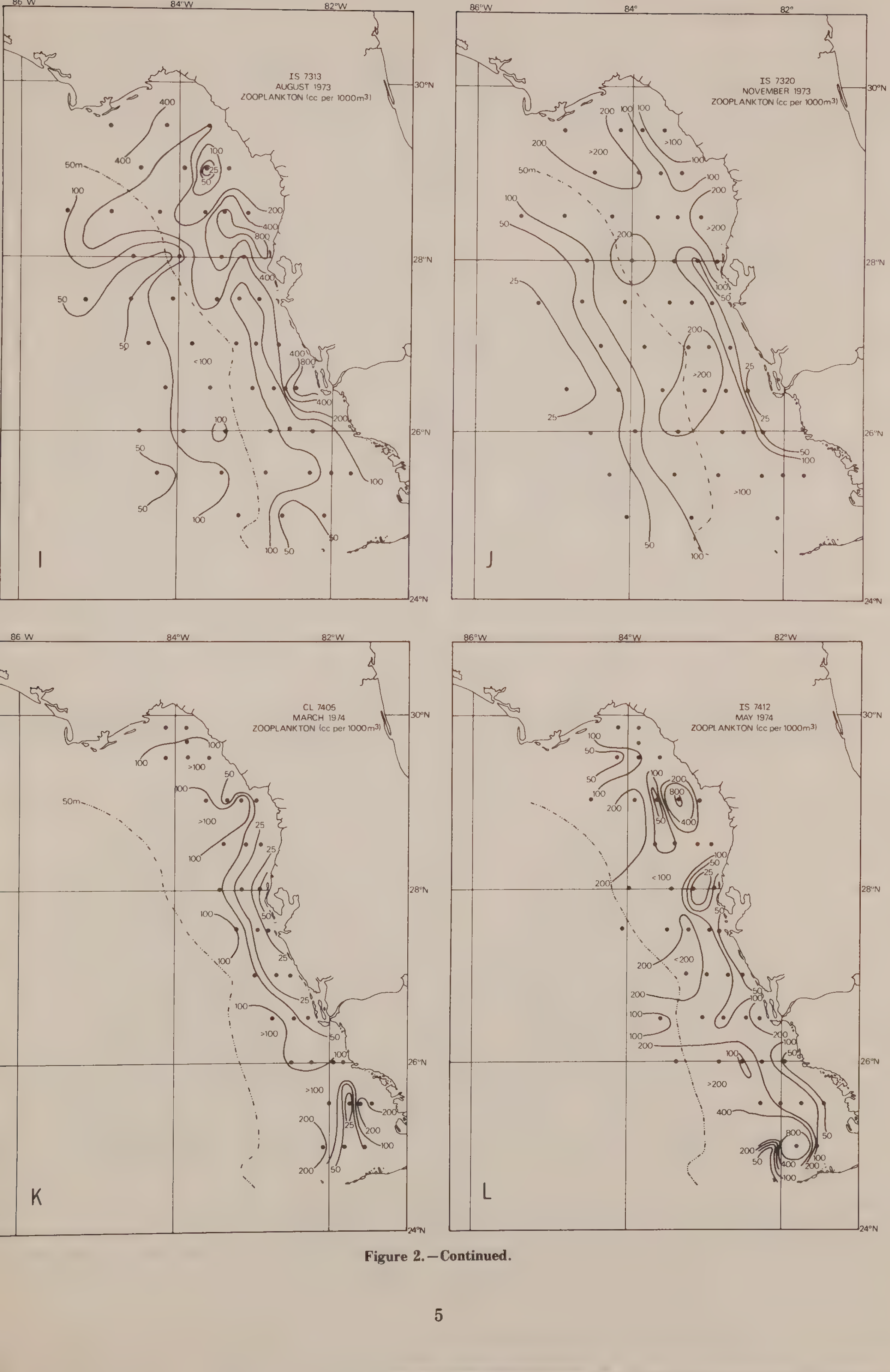

86°W
84°W
82°W
30°N
28°N
26°N
24°N
IS-7209
NOVEMBER 1972
ZOOPLANKTON (cc per 1000m3)
50m
E
IS-7303
JANUARY 1973
ZOOPLANKTON (cc per 1000m3)
50m
F
IS-7308
MAY 1973
ZOOPLANKTON (cc per 1000m3)
50m
G
IS-7311
JUNE-JULY 1973
ZOOPLANKTON (cc per 1000m3)
50m
H

Figure 2.—Continued.



86 W
84°W
82°W
30°N
28°N
26°N
24°N
IS 7313
AUGUST 1973
ZOOPLANKTON (cc per 1000m3)
50m
I
IS 7320
NOVEMBER 1973
ZOOPLANKTON (cc per 1000m3)
J
CL 7405
MARCH 1974
ZOOPLANKTON (cc per 1000m3)
K
IS 7412
MAY 1974
ZOOPLANKTON (cc per 1000m3)
L

Figure 2.—Continued.

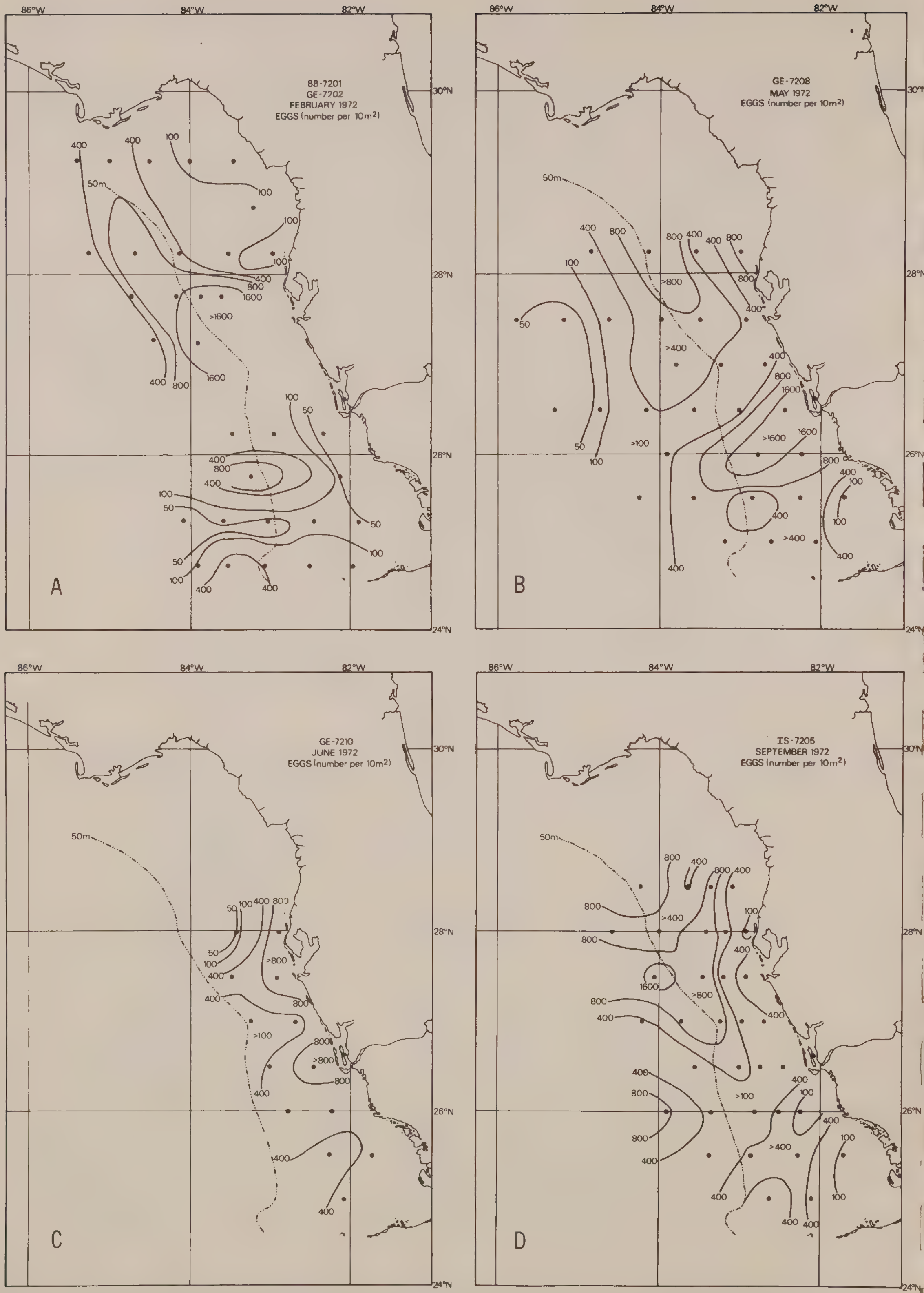
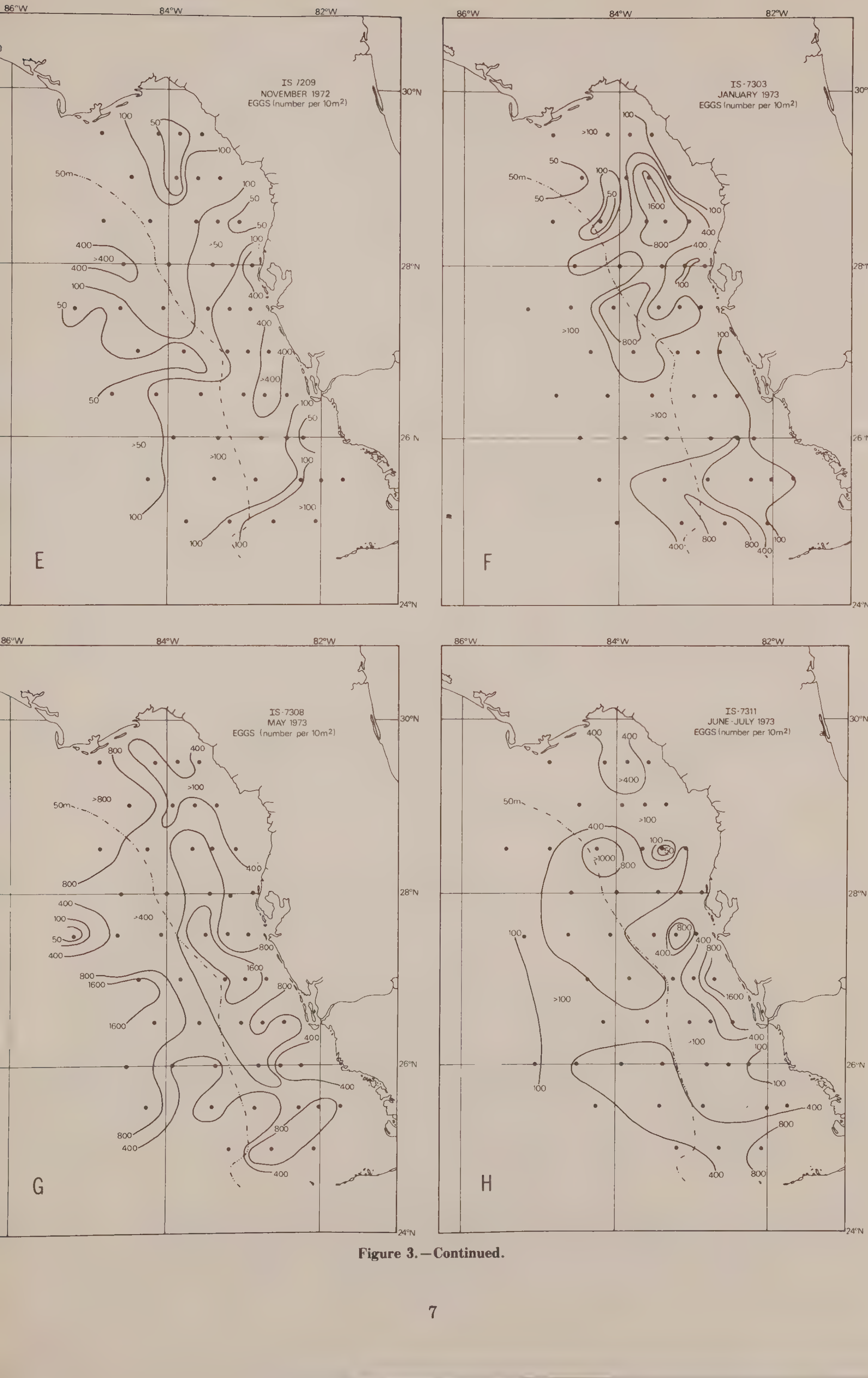

86°W
84°W
82°W
30°N
28°N
26°N
24°N
8B-7201
GE-7202
FEBRUARY 1972
EGGS (number per 10m²)
50m
>1600
A
GE-7208
MAY 1972
EGGS (number per 10m²)
>800
>400
>100
>1600
>400
B
GE-7210
JUNE 1972
EGGS (number per 10m²)
>800
>100
>800
C
IS-7205
SEPTEMBER 1972
EGGS (number per 10m²)
>400
>800
>100
>400
D

Figure 3.—Contour charts of fish egg abundance (numbers under 10 m² of sea surface) for 12 eastern Gulf of Mexico cruises, 1972-74.



IS 7209
NOVEMBER 1972
EGGS (number per 10m²)

IS-7303
JANUARY 1973
EGGS (number per 10m²)

IS-7308
MAY 1973
EGGS (number per 10m²)

IS-7311
JUNE-JULY 1973
EGGS (number per 10m²)

86°W
84°W
82°W
30°N
28°N
26°N
24°N
50m
E
F
G
H
50
100
>50
>100
400
>400
800
>800
1600
>1000

Figure 3.—Continued.

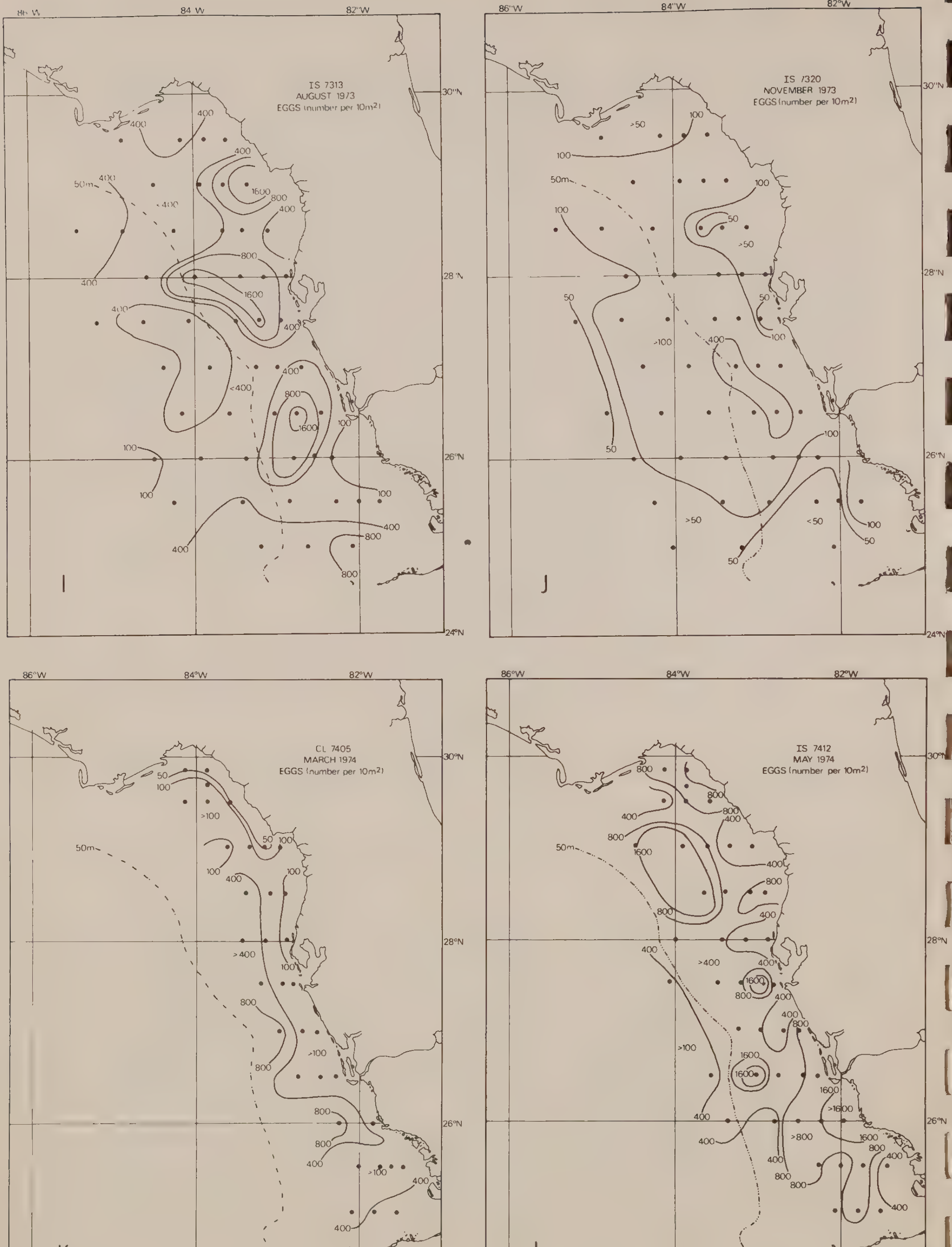
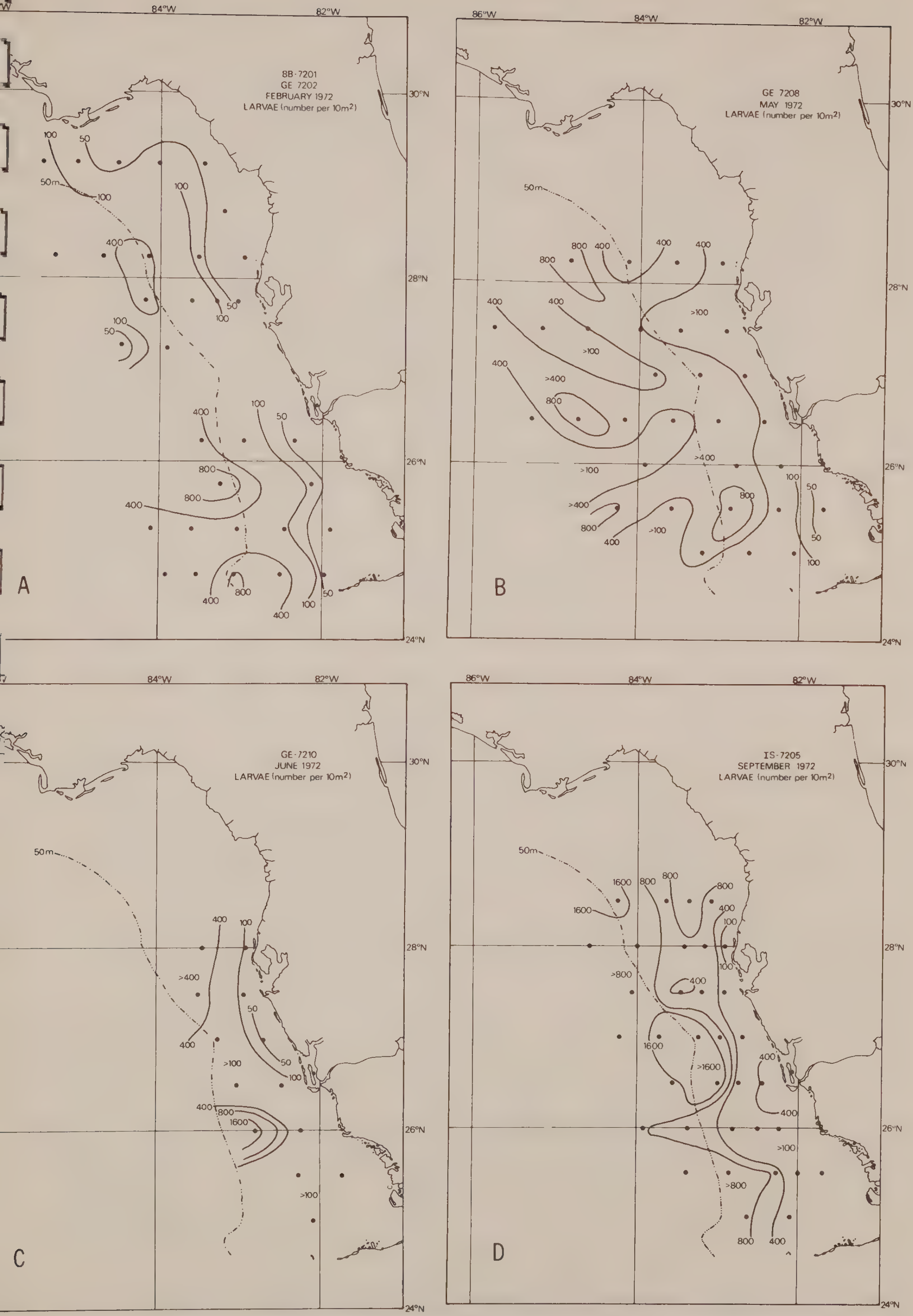

86°W
84°W
82°W
30°N
28°N
26°N
24°N
IS 7313
AUGUST 1973
EGGS (number per 10m^2)
50m
400
<400
800
1600
100
I
IS 7320
NOVEMBER 1973
EGGS (number per 10m^2)
>50
100
50m
50
>100
400
<50
J
CL 7405
MARCH 1974
EGGS (number per 10m^2)
50
100
>100
50m
400
>400
800
K
IS 7412
MAY 1974
EGGS (number per 10m^2)
800
400
1600
50m
>400
>100
>1600
>800
L

Figure 3.—Continued.


84°W
82°W
30°N
28°N
26°N
24°N
8B-7201
GE 7202
FEBRUARY 1972
LARVAE (number per 10m²)
100
50
50m
100
400
50
100
100
50
400
100
50
800
800
400
400
800
400
100
50
A
86°W
84°W
82°W
GE 7208
MAY 1972
LARVAE (number per 10m²)
50m
800
400
400
400
800
400
400
>100
>100
400
>400
800
>400
>100
800
>400
800
400
>100
100
50
50
100
B
84°W
82°W
GE-7210
JUNE 1972
LARVAE (number per 10m²)
50m
400
100
>400
50
400
>100
50
100
400
800
1600
>100
C
86°W
84°W
82°W
IS-7205
SEPTEMBER 1972
LARVAE (number per 10m²)
50m
1600
800
800
800
1600
400
100
>800
100
400
1600
>1600
400
400
>100
>800
800
400
D

e 4.—Contour charts of fish larvae abundance (number under 10 m² of sea surface) for 12 eastern Gulf of Mexico cruises, 1972-74.

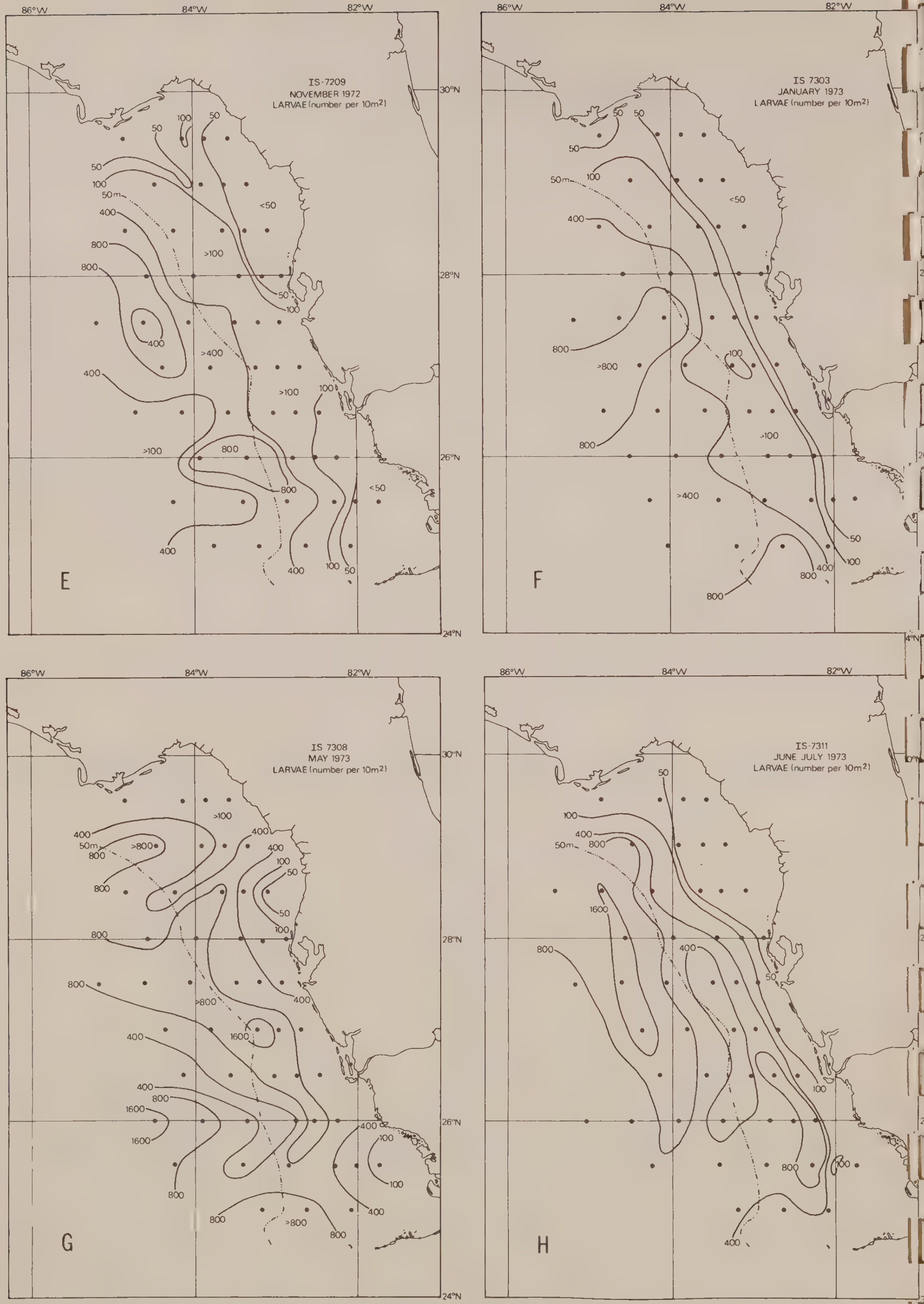
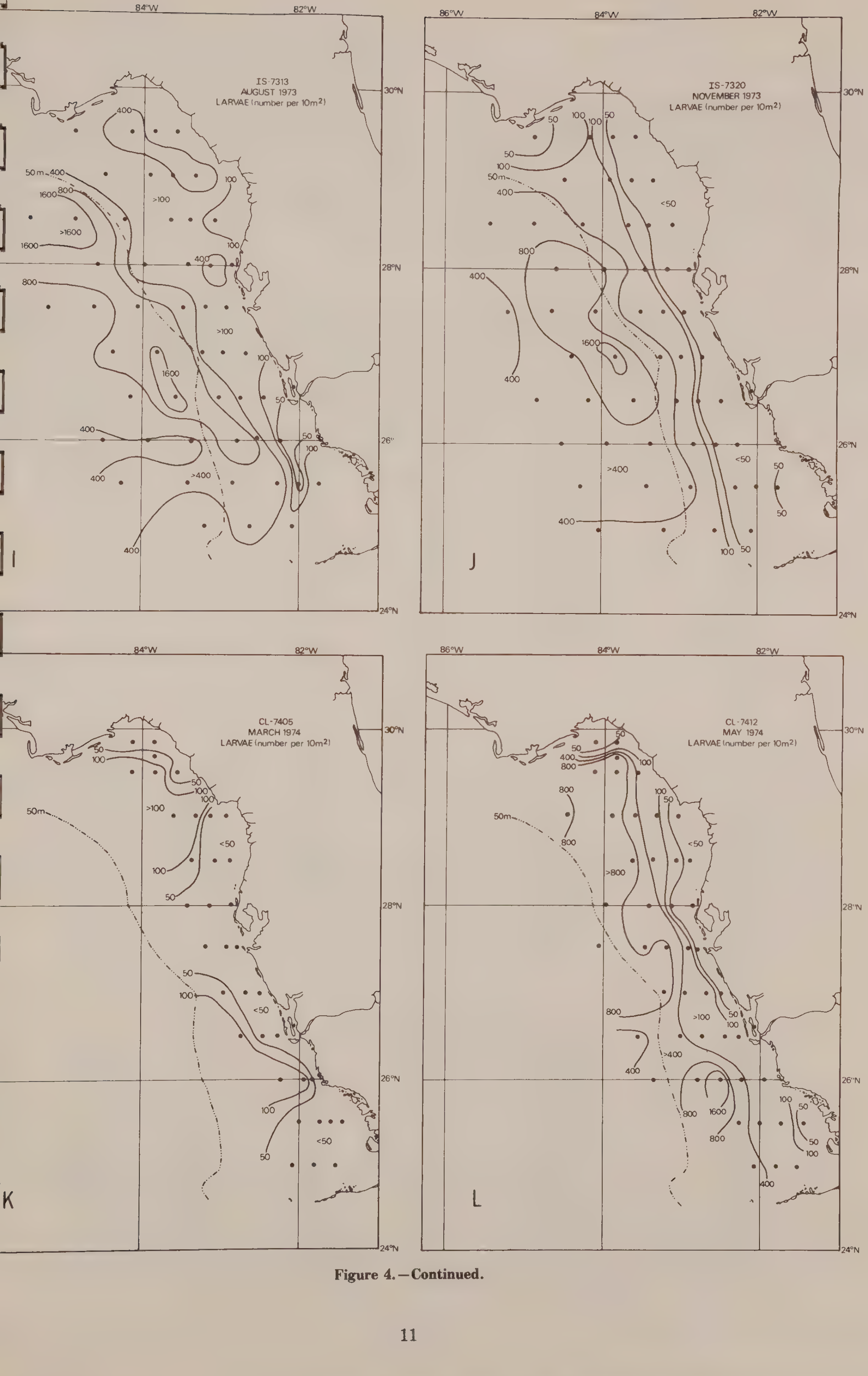

86°W
84°W
82°W
30°N
28°N
26°N
24°N
IS-7209
NOVEMBER 1972
LARVAE (number per 10m2)
50
100
50m
400
800
<50
>100
>400
800
400
<50
E
IS 7303
JANUARY 1973
LARVAE (number per 10m2)
50
100
50m
400
<50
800
>800
>100
>400
F
IS 7308
MAY 1973
LARVAE (number per 10m2)
>100
400
50m
>800
800
100
50
1600
>800
G
IS-7311
JUNE JULY 1973
LARVAE (number per 10m2)
50
100
400
50m
800
1600
H

Figure 4.—Continued.



IS-7313
AUGUST 1973
LARVAE (number per 10m2)
IS-7320
NOVEMBER 1973
LARVAE (number per 10m2)
CL-7405
MARCH 1974
LARVAE (number per 10m2)
CL-7412
MAY 1974
LARVAE (number per 10m2)
86°W
84°W
82°W
30°N
28°N
26°N
24°N
50m
>1600
1600
800
400
>400
>100
100
>800
<50
50
I
J
K
L

Figure 4.—Continued.

RESULTS

Nature of Distributions

Distributions of zooplankton, fish eggs, and fish larvae are patchy in the eastern Gulf (Figs. 2-4). Means, standard errors of the means, and coefficients of variation were calculated for each kind of observation for each cruise (Table 2). For the 12 cruises, mean zooplankton volumes ranged from 69.1 to 287.8 cc/1,000 m³ in the study area. The mean value for all cruises combined was 153.4 cc/1,000 m³. Mean numbers of fish eggs under 10 m² of sea surface ranged from 163.1 to 927.1 for the 12 cruises, and the poole combined cruises was 510.1. Fish larvae mean ranged from 55.3 to 825.4 under 10 m² of sea sur pooled mean was 435.5.

The relatively high standard errors and cients of variation (Table 2) reflect patchiness in of these organisms in the eastern Gulf. The c variation is a relative measure of the variabil dance or concentration. For plankton volumes, cient ranged from 56.3 to 187.2% on the averaging 91.8%. The range for fish egg abunda to 174.1%, averaging 99.4%. For fish larvae abu

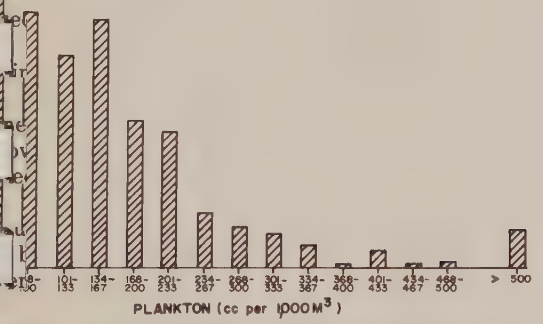
Table 2.—Mean zooplankton volumes (cubic centimeters per 1,000 m³), and numbers of fish eggs and larvae (numbers under 10 m² sea surface) for eastern Gulf of Mexico cruises, 1972-74.

Cruise	Cruise date	Number of observations	Mean	Standard error	Coefficient of variation (%)
		Zooplankton volumes (cc per 1,000 m³)			
8B 7201 & GE 7202	Feb. 1972	26	69.1	9.7	71.7
GE 7208	May 1972	28	107.1	16.7	82.4
GE 7210	June 1972	13	287.8	149.4	187.2
IS 7205	Sept. 1972	34	181.0	21.0	67.8
IS 7209	Nov. 1972	49	119.3	9.9	58.3
IS 7303	Jan. 1973	50	152.9	13.3	61.4
IS 7308	May 1973	49	204.3	25.0	85.8
IS 7311	June-July 1973	51	120.2	11.9	70.9
IS 7313	Aug. 1973	50	194.9	31.2	113.1
IS 7320	Nov. 1973	51	131.3	10.4	56.3
CL 7405	Mar. 1974	36	92.2	12.2	79.3
CL 7412	May 1974	45	219.1	54.6	167.1
Total		482	153.4	8.5	91.8
		Fish eggs (number under 10 m² sea surface)			
8B 7201 & GE 7202	Feb. 1972	30	517.6	164.5	174.1
GE 7208	May 1972	30	577.7	119.9	113.7
GE 7210	June 1972	13	527.2	85.4	58.4
IS 7205	Sept. 1972	34	578.8	72.5	73.1
IS 7209	Nov. 1972	50	186.5	21.9	83.0
IS 7303	Jan. 1973	51	374.9	58.8	112.1
IS 7308	May 1973	49	872.2	129.7	104.1
IS 7311	June-July 1973	51	450.2	50.2	79.6
IS 7313	Aug. 1973	50	725.1	158.5	154.6
IS 7320	Nov. 1973	51	163.1	18.4	80.7
CL 7405	Mar. 1974	32	291.1	42.6	82.7
CL 7412	May 1974	42	927.1	109.0	76.2
Total		483	510.1	30.3	99.4
		Fish larvae (number under 10 m² sea surface)			
8B 7201 & GE 7202	Feb. 1972	30	226.6	46.2	111.7
GE 7208	May 1972	30	414.3	47.5	62.8
GE 7210	June 1972	13	341.5	130.9	138.1
IS 7205	Sept. 1972	34	825.4	112.1	79.2
IS 7209	Nov. 1972	50	295.5	45.6	109.0
IS 7303	Jan. 1973	51	301.2	45.1	106.9
IS 7308	May 1973	49	613.5	62.5	71.3
IS 7311	June-July 1973	51	551.5	77.8	100.8
IS 7313	Aug. 1973	50	581.6	94.8	115.2
IS 7320	Nov. 1973	51	346.0	55.5	114.5
CL 7405	Mar. 1974	32	55.3	12.6	129.3
CL 7412	May 1974	42	519.2	89.7	112.0
Total		483	435.5	19.5	104.2

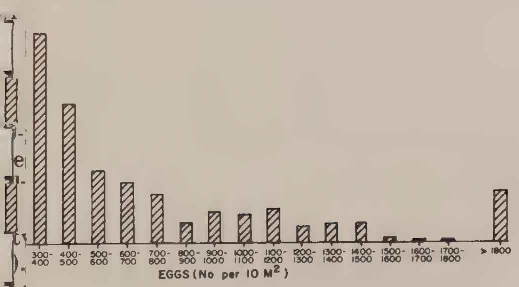
t ranged from 62.8 to 138.1%, averaging 104.2%. y distributions of abundance from pooled data of all demonstrate the patchy nature of the distribu- or modest catches were observed most fre- igs. 5-7), but very high abundances or concen- f organisms occurred at a few stations during each quency distributions for individual cruises, llustrated here, closely resembled those for the a., demonstrating that the patchy nature of the ons is not a seasonal phenomenon but occurs the year.

y of Abundance

kton volumes and spawning by fishes show a onality in the eastern Gulf (Table 2; Figs. 8-10). lumes are largest and fish eggs and fish larvae abundant in the spring and summer months (May eptember cruises). Fall and winter (November rch cruises) abundance is less, but the decrease arent for eggs and larvae than for zooplankton Mean fall-winter zooplankton volumes were less c/1,000 m³ while spring-summer means increased 000 m³ or more. A sharp drop in mean zoo-



equency distribution of zooplankton volumes, based on ll stations made during 12 eastern Gulf of Mexico cruises,



Frequency distribution of fish egg abundance based on ll stations made during 12 eastern Gulf of Mexico cruises,

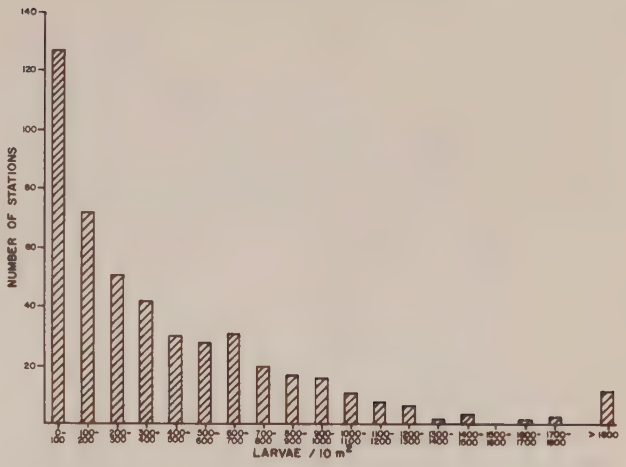


Figure 7.—Frequency distribution of fish larvae abundance based on samples from all stations made during 12 eastern Gulf of Mexico cruises, 1972-74.

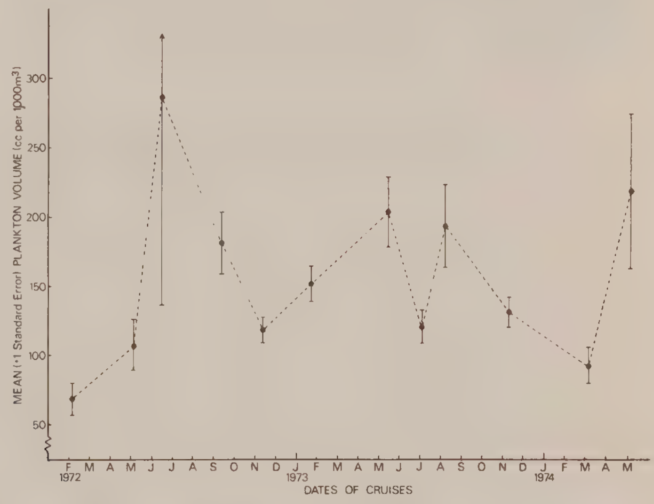


Figure 8.—Mean zooplankton volumes for 12 eastern Gulf of Mexico cruises, 1972-74.

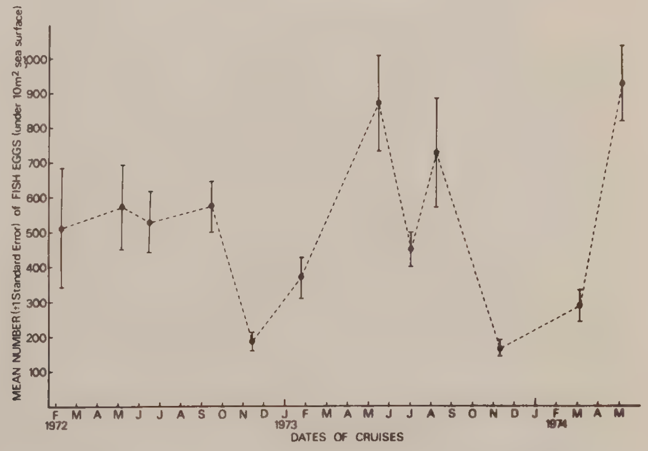


Figure 9.—Mean fish egg abundance for 12 eastern Gulf of Mexico cruises, 1972-74.

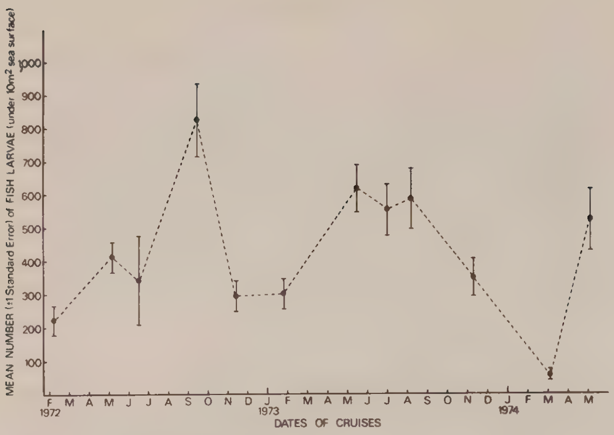


Figure 10.—Mean fish larvae abundance for 12 eastern Gulf of Mexico cruises, 1972-74.

plankton volume was observed in June-July 1973, along with similar decreases in ichthyoplankton abundance. There was a recovery in abundance by August 1973. Mean abundance of fish eggs was less than 300 under 10 m^2 of sea surface during fall-winter but exceeded 550 during the sp mer months. Fish larvae mean abundance was less under 10 m^2 in fall-winter, increasing to more spring-summer.

North-South Distribution

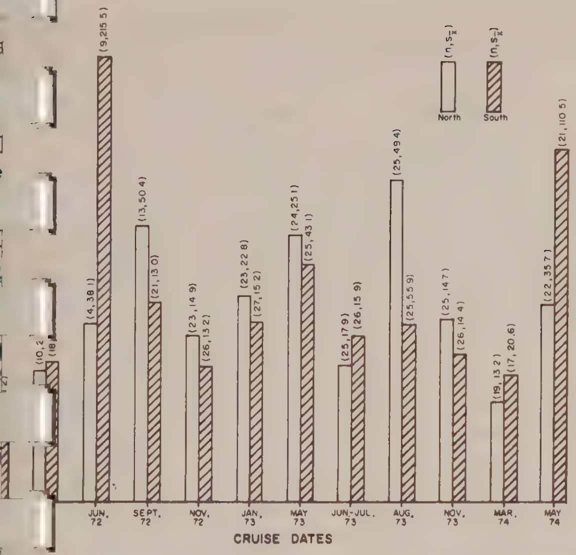
Zooplankton and ichthyoplankton were ex each cruise in relation to latitude. The study are trarily divided into halves at lat. 27°15′N (Fig. 1 north and south of this line were compared to de abundance differed greatly between the two ar

Mean abundance of eggs and larvae and volumes usually were greatest north of lat. 27°15 3; Figs. 11, 12). Only fish larvae had a higher po abundance (number under 10 m^2) in the souther area for all cruises combined. The contour organism distribution (Figs. 2-4) do not readily mean abundance tended to be higher north of lat because of the patchy nature of the distributio

Mean zooplankton volumes were highest i ern sector for 7 of the 12 cruises (Table 3; Fig. 11 the five exceptions occurred during spring and cruises. Mean fish egg abundance was highest i during 6 of the 12 cruises (Table 3; Fig. 12). mean abundance of eggs for all cruises was highe

Table 3.—Summary of plankton, fish eggs, and fish larvae data for each cruise, after dividing the cruise area into northern (above lat. 27°15′N) and southern (below lat. 27°15′N) portions. Tabulated values are means. Values in parentheses are the numbers of stations that were sampled.

		Plankton volume (cc/1,000 m³)		Fish eggs (No./10 m²)		Fish larvae (No./10 m²)	
Cruise	Month	North	South	North	South	North	South
1972							
GE 7202 & 8B 7201	Feb.	76.9 (10)	65.9 (15)	722.3 (13)	221.8 (15)	162.9 (13)	297.1 (15)
GE 7208	May	103.6 (10)	111.0 (18)	497.2 (10)	617.8 (20)	406.7 (10)	418.1 (20)
GE 7210	June	142.2 (4)	352.5 (9)	656.4 (4)	469.8 (9)	340.3 (4)	342.1 (9)
IS 7205	Sept.	218.1 (13)	158.1 (21)	764.2 (13)	464.0 (21)	764.4 (13)	863.2 (21)
IS 7209	Nov.	132.1 (23)	108.0 (26)	166.2 (24)	205.2 (26)	206.6 (24)	377.9 (26)
1973							
IS 7303	Jan.	164.4 (23)	143.1 (27)	451.3 (24)	307.0 (27)	219.3 (24)	374.3 (27)
IS 7308	May	220.9 (24)	188.4 (25)	845.2 (24)	898.1 (25)	477.2 (24)	744.4 (25)
IS 7311	June-July	108.2 (25)	131.9 (26)	415.5 (25)	481.4 (25)	466.6 (25)	633.0 (26)
IS 7313	Aug.	255.9 (25)	141.5 (25)	909.2 (25)	492.4 (25)	621.9 (25)	541.2 (25)
IS 7320	Nov.	145.1 (25)	118.1 (26)	150.7 (25)	175.1 (26)	288.9 (25)	401.0 (26)
1974							
IS 7405	Mar.	80.0 (19)	101.5 (17)	191.1 (16)	391.1 (16)	60.4 (16)	50.2 (16)
IS 7412	May	157.3 (22)	278.8 (21)	926.1 (23)	384.5 (19)	497.2 (23)	545.8 (19)
Pooled means		157.1 (223)	150.3 (256)	545.4 (226)	463.4 (225)	380.5 (226)	486.9 (255)



11.—Comparison of mean zooplankton volumes for stations d north of lat. 27°15′N and stations south of that latitude for 12 of Mexico cruises, 1972-74. Numbers of stations and rs of the mean are given in parentheses above bar graphs.

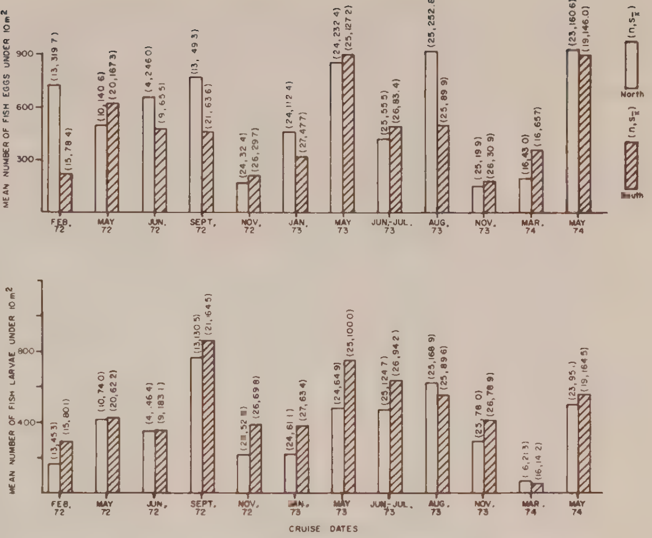


Figure 12.—Mean fish egg and fish larvae abundance. Comparisons are made for stations sampled north of lat. 27°15′N and stations south of that latitude for 12 eastern Gulf of Mexico cruises, 1972-74. Numbers of stations and standard errors of the mean are given in parentheses above bar graphs.

ctor (Table 3). There was no apparent seasonal t explained the occurrence of the highest mean nce in the southern sector for six cruises (Fig. he mean abundance of fish larvae was highest in the ector during only 2 of the 12 cruises (Table 3;

ng by fishes seems to be more intensive in the rn sector, but larval abundance usually is not highest er mortality rates in the north, transport out of ward the south, or transport of larvae into the ector from outside the sampling area could t for the observed distributions. Mean zooplankton es ually were highest in the northern sector but between sectors were not often great, pooled ring by only 7 cc/1,000 m³ between the two (Table 3).

he easonality of abundance that was observed pre- en the whole shelf area was considered, also was each of the sectors (Figs. 11, 12). Zooplankton es were lowest in winter and highest in summer for he rthern and southern sectors, although the degree during summer was greatest in the southern ndance of ichthyoplankton also reflected the al pattern of relative scarcity in winter and increased ance in summer in each of the sectors.

bution Relative to the 50-m Depth Contour

-m isobath divides the shelf study area into e halves (Fig. 1). Zooplankton volumes and oplankton abundance and concentrations were ex- d in relation to this depth contour to determine if they tween nearshore and offshore areas (Table 4;). The nature of water masses, rather than depth actor determining zooplankton and ichthyoplankton ance, but the 50-m depth is a convenient, common comparing cruises. Gulf Loop Current water nally intrude onto the west Florida continental shelf where depths range from 50 to 200 m (Maul 1974) and the character of zooplankton and ichthyoplankton could be influenced by such intrusions (Austin 1974). We did not determine if differences in plankton species composition occurred during this study.

Mean volumes of zooplankton were greatest at stations less than 50 m deep on 8 of the 10 cruises where stations in both depth zones were sampled. The two exceptions occurred in February 1972 and June-July 1973 when the mean volumes of zooplankton were slightly higher over the outer shelf. Pooled mean zooplankton volumes for the 10 cruises were calculated for each of the two depth zones (Table 4). Mean volume at depths shallower than 50 m exceeded that at deeper stations by a factor of 1.78. For the 10 cruises in which both depth zones were sampled, mean zooplankton volumes at stations shallower than 50 m exceeded 150 cc/1,000 m³ seven times, but mean plankton volume exceeded that amount on only one cruise at stations deeper than 50 m.

Mean fish egg abundance usually was higher at stations less than 50 m deep but mean larval abundance was always higher at the deeper stations for the 10 cruises. One reason for this observation is that fish larvae range in age from 1 day to more than 3 wk. Fish eggs, by contrast, usually hatch within 2 days of spawning in the eastern Gulf, precluding the possibility of numbers accumulating over a period in any area. Therefore, abundance of eggs would tend to be highest where the eggs were spawned in greatest numbers. Other reasons that larval abundance may be relatively low at shallow stations are that a higher proportion of shallow-water species are demersal and furthermore their larvae become demersal at a younger age than larvae of demersal, offshore species.

Seasonal fluctuations of zooplankton and ichthyoplankton abundance were most apparent at stations less than 50 m deep. Plankton volumes usually increased in summer at stations located over deeper water (Fig. 13) but the relative increase in zooplankton was less than at shallower stations.

Table 4.—Summary of plankton, fish eggs, and fish larvae mean catches for each cruise, dividing the cruise into portions greater than 50 m depth and less than 50 m depth.

Cruise	Month	Plankton volume (cc/1,000 m³)		Fish Eggs (No./10 m²)		Fish Larvae (No./10 m²)	
		<50 m	>50 m	<50 m	>50 m	<50 m	>50 m
1972							
8B 7201 & GE 7202	Feb.	68.8 (15)	69.6 (12)	420.1 (18)	880.3 (12)	153.2 (18)	336.7 (12)
GE 7208	May	158.2 (15)	48.2 (13)	820.0 (16)	300.6 (14)	348.8 (16)	489.1 (14)
GE 7210	June	-----No stations were greater than 50 m deep-----					
IS 7205	Sept.	195.7 (26)	120.7 (8)	559.9 (26)	640.1 (8)	742.9 (26)	1,093.7 (8)
IS 7209	Nov.	144.6 (33)	67.1 (16)	198.4 (34)	161.0 (16)	134.8 (34)	638.0 (16)
1973							
IS 7303	Jan.	181.1 (33)	107.1 (17)	419.0 (34)	362.2 (17)	146.1 (34)	645.3 (17)
IS 7308	May	237.6 (34)	128.9 (15)	955.2 (34)	684.0 (15)	545.8 (34)	767.0 (15)
IS 7311	June-July	118.2 (34)	124.2 (17)	483.8 (34)	379.7 (17)	328.7 (34)	997.0 (17)
IS 7313	Aug.	232.6 (34)	114.9 (16)	857.2 (34)	368.4 (16)	363.1 (34)	1,045.8 (16)
IS 7320	Nov.	158.3 (32)	100.6 (18)	364.3 (32)	138.1 (18)	121.5 (32)	698.2 (18)
1974							
CL 7405	Mar.	-----No stations were greater than 50 m deep-----					
CL 7412	May	215.1 (41)	191.7 (3)	937.4 (39)	354.9 (3)	508.7 (39)	655.5 (3)
Pooled means		178.9 (297)	100.7 (135)	606.4 (301)	402.8 (136)	342.2 (301)	739.2 (136)

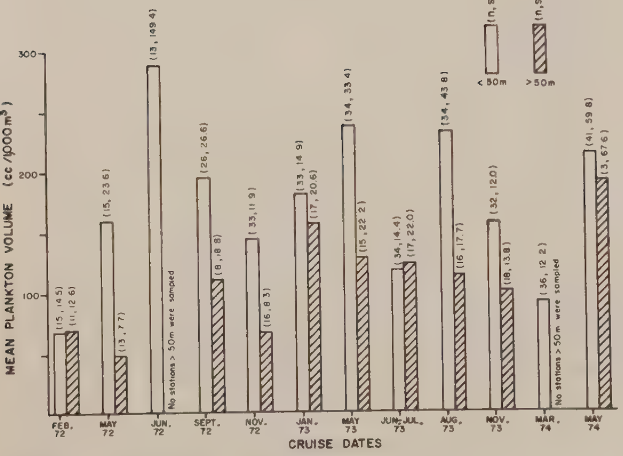


Figure 13.—Comparison of mean zooplankton volumes between stations less than 50 m deep and those more than 50 m deep for 12 eastern Gulf of Mexico cruises, 1972-74. Numbers of stations and standard errors of the means are given in parentheses above bar graphs.

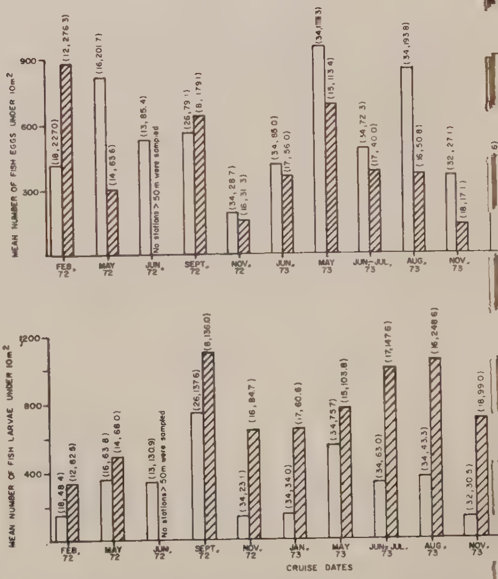


Figure 14.—Mean fish egg and fish larvae abundance. Co made between stations less than 50 m deep and those mo deep for 12 eastern Gulf of Mexico cruises, 1972-74. Numbe and standard errors of the means are given in parenthe graphs.

of the observed seasonality in larval fish abundance
ttributable to changes at stations shallower than 50 m
14

Areas of Abundance

The patchy nature of zooplankton distribution in the rn Gulf made it difficult to determine if any areas y had high biomass. The contour charts (Fig. 2) t that an area on the southwest Florida shelf, npassed by lat. 25°30′N to 27°30′N and long. 82°30′W °00′W, usually had high zooplankton volumes. This n is similar to that of Bogdanov et al. (1968) and (1969) who observed year-round high plankton ing stocks in this area during 1963 and 1964.

Another area of relatively high plankton volumes was the shelf in the northeast Gulf (lat. 28°N to 29°N 34°W to 85°W). Our data show this area to be n zooplankton at all seasons but richest in summer, differing from data of Bogdanov et al. (1968) and (1969), who reported high plankton biomass in winter. Because their observations apparently led phytoplankton biomass, as well as zooplankton, our may not be directly comparable. Austin and Jones) reported a high zooplankton biomass in this cited possible influences of the Loop Current and circulation on production. Their data, based on nly collections from June 1969 through August 1970, nkton biomass for this area of the Gulf to be February and March, then increasing rapidly gh May and June, and reaching a peak in fall.

ooplankton volumes frequently were high in small the coast, but none of these areas had consis- volumes. Such areas included coastal stations of Charlotte Harbor (lat. 26°30′N), Tampa Bay (lat. N) and Cedar Key (lat. 29°00′N). Nutrients from local runoff may have a major influence on plankton in these areas.

ontour charts of fish egg abundance (Fig. 3) show less mity than those for zooplankton volumes. Egg abun- ow during fall and winter; the only area that had igh numbers of eggs at those seasons was located en Charlotte Harbor and Tampa Bay at depths of 20 to . During spring and summer, spawning is intense but unusually great spawning activity were located. high abundance (>1,600 eggs under 10 m^2) often d these usually were found where depths ranged 20 to 50 m.

bundance of fish larvae (number under 10 m^2) was depths from 50 to 100 m (Fig. 4). Contour lines of abundance tended to lie parallel to isobaths. est abundance of larvae occurred between lat. 26°30′N 3°30′N. Localized patches of great abundance some- observed for larvae, but these were less common h eggs.

ionships Among Biological Variables

ex statistical analyses were not undertaken to elationships among the plankton and ichthyo- on categories. Simple correlation coefficients among of variables for each cruise were calculated, however, e if any of them had a significant linear associa- 5). All of the correlations were calculated using transformed data because most of the cruise frequency butions for abundance or concentrations were nearly stributed after transformation.

Table 5.—Summary of simple correlations among biological variables. All correlation coefficients were calculated using log$_{10}$-transformed data.

Cruise	Plankton (cc/1,000 m^3) by fish eggs (No./10 m^2)	Plankton (cc/1,000 m^3) by fish larvae (No./10 m^2)	Fish eggs (No./10 m^2) by fish larvae (No./10 m^2)
8B 7201 & GE 7202	+0.281	+0.218	+0.389*
GE 7208	+0.631**	+0.097	+0.087
GE 7210	-0.172	+0.727**	-0.329
IS 7205	+0.283	+0.109	+0.610**
IS 7209	+0.038	-0.179	+0.021
IS 7303	+0.022	-0.118	+0.172
IS 7308	+0.205	-0.056	+0.070
IS 7311	-0.074	+0.347*	+0.252
IS 7313	+0.171	-0.241	-0.012
IS 7320	+0.211	-0.000	+0.376**
CL 7405	-0.044	+0.450**	+0.346
CL 7412	+0.309*	+0.359*	+0.258

* Significant; $P < 0.05$
** Highly significant; $P < 0.01$

The correlations between zooplankton volumes and fish egg abundance were positive for nine cruises, but significantly so ($P < 0.05$) for only two of these. This suggests that there is a relationship between areas of intense spawning and high zooplankton abundance at some times. The correlations between fish egg abundance and fish larvae abundance, though positive on 10 of the 12 cruises, were significant in only three cases. The fact that only positive correlation coefficients were significant among those that were calculated (Table 5) supports the belief that there is at times a real association among these variables in the eastern Gulf.

Relationships of Biological Variables to Temperature and Salinity

There were no obvious associations among temperature and salinity conditions and the distribution of organisms. Such associations almost certainly would be species dependent; because we did not identify organisms to the species level or sample discrete depth strata, these associations were not observed. Even in summer 1973, when a lens of low salinity water (<30‰) was located over part of the shelf study area, predominantly from Mississippi flood runoff, the effects on the plankton were not obvious. Zooplankton volumes, fish egg abundance, and larval fish abundance were all reduced during the June-July 1973 cruise (Figs. 8-10), but had recovered by August 1973, although surface salinities remained low in the area. Because this low salinity water was present only from the surface to 15-m depth, it is possible that many planktonic organisms that remained below that depth were not seriously affected. It is not known what effects this low salinity lens had on spawning, egg development, or larval survival for those species that normally are found near the sea surface.

ACKNOWLEDGMENTS

Particular thanks go to Steven Berkeley, Lise Dowd, John Klinovsky, Betsy Sullivan, and Gregg Waugh, all of whom helped to prepare and reduce data for this report. We thank Murice Rinkel of the State University System of Florida Institute of Oceanography, and James Price and C. N. K. Mooers of the Rosenstiel School of Marine and Atmospheric Science for providing assistance in digitizing and plotting hydrographic data. Financial support for this project was provided by NOAA Sea Grant 04-3-158-27 to the University of Miami and by Bureau of Land Management Contract No. 08550-CT4-16.

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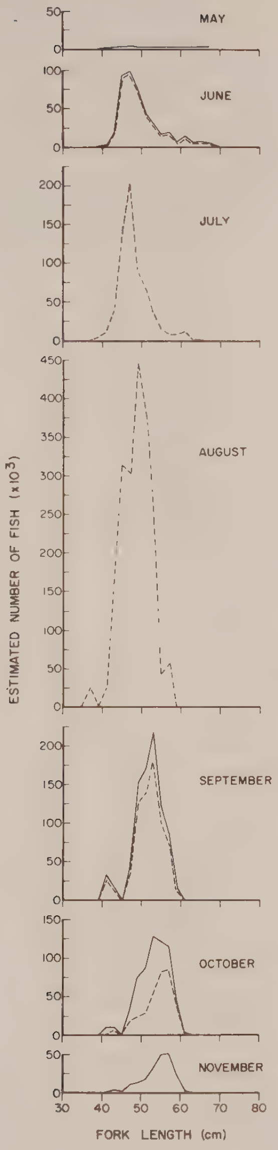
—Estimated length position of skipjack tuna nonth caught by American in 1970. (Solid ratified procedure stituted samples; hed line — stratified cedure without sub- samples and strata sample.)



cipally the estimates of fish caught at the beginning and end (September-November) of the 1970 eason. The effects are greater for yellowfin tuna than for skipjack tuna (Fig. 7).

DISCUSSION

stimates of length composition of the American ches of yellowfin and skipjack tunas from the eastern Atlantic have been published in the data records ernational Commission for the Conservation of antic Tunas (1973; 1974b, c). The published es- were based on preliminary data on total catches stratified procedure with unweighted samples; sequently, they underestimated the numbers of fish caught and are not comparable to our estimates. Our estimates were based on total catches and on weighted samples. We consider them to be more accurate than those published in the data records.

The stratified procedure was used in our study to gain greater precision in our estimates. However, in years when sampling coverage was poor, the stratified procedure probably was inappropriate and may have distorted the results. In such circumstances, the unstratified procedure may have been more appropriate. Estimates based on the unstratified procedure are shown by dashed lines in Figures 2 and 3.

The stratified procedure is the most desirable for estimating the size composition of the catch of tunas because it can result in precise estimates (Hennemuth 1957). The choice between the unstratified and stratified procedures should be based on sampling cost as well as precision. For the American tuna catches from the eastern tropical Atlantic, the sampling cost is currently not much greater with the stratified than the unstratified procedure. The choice then is to use the stratified procedure which can account for area-time differences in the sizes of fish caught. If the sampling coverage is poor, however, particularly for yellowfin tuna with a wide range of sizes, the full advantage of the stratified procedure is lost and the estimates would not be very different from those based on the unstratified procedure. In this case, the procedures are equally precise in estimating the size composition of the catch and either procedure can be used without fear of losing more precision from one than the other.

ACKNOWLEDGMENTS

We thank C. J. Orange of the IATTC who supervised the collection of much of the data used in this report. W. H. Lenarz of the Southwest Fisheries Center (SWFC) initiated the sampling program and generously provided information on the sampling design. W. W. Fox, Jr. and W. H. Lenarz of SWFC; Z. Suzuki of the Far Seas Fisheries Research Laboratory, Fisheries Agency of Japan; and P. K. Tomlinson of the IATTC read the manuscript and offered helpful comments.

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dix Table 1.— Estimated length composition of yellowfin ught by American purse seiners in the eastern tropical Atlantic in 1968.

Midpoint length m)	Number of fish by month		
	Aug.	Sept.	Oct.
0	1143	1948	0
61.0	2644	9460	0
63.0	8583	20216	7688
65.0	7313	16765	25628
0	5043	21756	23065
0	3861	3868	15377
0	2050	8371	5126
73.0	3570	7177	5126
75.0	1286	9878	5126
0	26	5672	2563
0	1561	2726	0
0	1479	777	2563
83.0	2061	1891	2563
85.0	877	2178	5126
0	83	1113	5126
0	480	6412	0
0	500	1737	7688
93.0	21	1886	5126
95.0	21	187	0
97.0	1041	717	2563
0	26	0	2563
0	0	0	5126
10 0	0	336	0
105.0	0	0	0
107.0	582	706	0
0	0	0	0
.0	230	706	0
.0	661	0	0
115.0	440	243	0
117.0	10	94	0
.0	0	0	0
.0	5	275	0
.0	5	66	0
125.0	0	243	0
127.0	453	628	0
129.0	443	611	0
.0	318	1782	0
.0	518	2449	0
135.0	853	3534	0
137.0	2478	2883	0
139.0	351	2583	0
.0	961	2469	0
.0	1456	2517	0
.0	3015	2021	0
147.0	2128	2077	0
149.0	766	1102	0
.0	1882	1163	0
.0	1772	1780	0
.0	507	582	0
157.0	942	663	0
159.0	1539	872	0
.0	902	517	0
.0	762	681	0
.0	399	196	0
167.0	1539	229	0
169.0	705	421	0
171.0	606	98	0
.0	440	131	0
.0	0	66	0
.0	0	33	0
Total	71337	159492	128143

Appendix Table 2.— Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1969.

Midpoint length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
39.0	0	0	0	243	0
41.0	0	0	0	0	0
43.0	0	0	0	0	0
45.0	1100	0	146	0	0
47.0	1100	857	1583	0	0
49.0	1100	1501	1715	83	0
51.0	0	3672	146	1131	0
53.0	0	6002	0	2180	0
55.0	5502	4502	1467	83	0
57.0	9903	4502	1147	3311	0
59.0	16505	6002	858	12663	0
61.0	2201	7503	73	13712	0
63.0	1100	0	0	0	0
65.0	1100	0	0	1048	0
67.0	0	0	0	0	0
69.0	0	0	0	83	0
71.0	0	0	0	0	0
73.0	0	0	0	0	0
75.0	0	0	0	0	0
77.0	0	0	0	0	0
79.0	1100	0	0	0	0
81.0	0	0	0	0	0
83.0	0	0	0	0	0
85.0	0	0	0	0	0
87.0	0	0	0	0	0
89.0	0	0	0	0	0
91.0	0	0	721	0	0
93.0	0	0	0	0	0
95.0	0	0	721	0	0
97.0	0	993	0	0	0
99.0	0	0	721	0	0
101.0	0	0	0	0	0
103.0	1100	0	721	0	0
105.0	0	3429	1442	0	0
107.0	2201	15538	2163	0	0
109.0	1100	29220	8074	1362	0
111.0	2201	49690	5190	0	0
113.0	1100	48992	6716	3772	0
115.0	0	27385	5707	9150	317
117.0	0	12022	6200	12679	0
119.0	1100	7272	3655	19093	0
121.0	0	3346	7439	16464	0
123.0	0	6337	3444	10518	317
125.0	1100	7228	5542	6580	0
127.0	1100	4388	4776	5230	0
129.0	1100	3532	7087	2807	713
131.0	0	2099	10621	0	1030
133.0	1100	835	8333	83	1830
135.0	1100	1341	7489	1937	2695
137.0	0	186	3345	166	2695
139.0	0	0	2058	243	2061
141.0	0	1642	1149	326	2638
143.0	0	1188	3686	326	2507
145.0	0	929	2692	409	4575
147.0	0	1341	3417	1463	4222
149.0	0	671	2379	415	4444
151.0	0	0	2245	1297	4092
153.0	0	671	3087	569	5433
155.0	0	0	1349	811	4898
157.0	0	259	1924	984	3730
159.0	0	0	1273	1540	2832
161.0	0	0	563	1297	735
163.0	0	0	497	811	173
165.0	0	0	248	971	483
167.0	0	0	392	0	173
169.0	0	0	0	243	0
171.0	0	0	0	0	0
173.0	0	0	0	728	0
Total	55013	265075	134201	136811	52593

Appendix Table 3.— Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1970.

Midpoint length (cm)	Number of fish by month						
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
37.0	0	0	343	0	0	0	0
39.0	0	0	343	0	0	0	0
41.0	0	0	0	0	0	0	0
43.0	0	0	538	862	0	0	0
45.0	1	225	2135	862	0	49	16
47.0	0	0	881	12636	0	0	0
49.0	0	0	1076	5787	0	0	0
51.0	7	1222	2135	19562	0	0	0
53.0	37	6446	6565	38463	0	1456	466
55.0	24	4263	14769	143727	0	1208	387
57.0	10	1821	9606	147666	7427	1698	544
59.0	2	352	538	19331	37135	6729	2154
61.0	1	147	715	2586	29708	19557	6259
63.0	2	373	186	0	74269	16894	5407
65.0	0	0	0	0	29708	15986	5116
67.0	1	106	0	0	22281	14531	4651
69.0	0	0	343	0	37135	2664	852
71.0	2	386	715	0	22281	6686	2140
73.0	1	171	1774	0	29708	1456	466
75.0	2	260	0	0	29708	9941	3182
77.0	0	0	4292	0	29708	5526	1769
79.0	2	345	1774	3925	14854	9005	2882
81.0	1	106	1059	0	7427	0	0
83.0	1	246	3763	0	0	1456	466
85.0	0	0	4478	0	0	1504	481
87.0	2	400	1253	0	0	0	0
89.0	2	281	715	0	0	1456	466
91.0	1	171	687	0	0	49	16
93.0	0	0	881	0	0	0	0
95.0	0	0	1431	0	0	49	16
97.0	0	0	0	0	0	3008	963
99.0	3	559	687	3925	0	49	16
101.0	1	134	2312	0	0	0	0
103.0	1	150	1059	0	0	0	0
105.0	1	134	1597	3925	0	49	16
107.0	0	37	1059	7850	0	0	0
109.0	0	0	1940	3925	0	146	47
111.0	0	0	2833	0	0	146	47
113.0	1	134	343	0	0	97	31
115.0	1	106	1245	0	0	97	31
117.0	0	0	0	0	0	49	16
119.0	1	106	0	0	0	0	0
121.0	2	392	0	0	0	0	0
123.0	2	345	902	0	0	0	0
125.0	4	708	1253	0	0	49	16
127.0	2	350	538	0	0	0	0
129.0	2	407	1076	0	0	0	0
131.0	2	366	538	0	0	0	0
133.0	4	729	538	0	0	0	0
135.0	4	680	50	0	0	0	0
137.0	7	1294	1464	11774	0	0	0
139.0	3	492	237	0	0	1208	387
141.0	4	617	816	0	0	2319	742
143.0	3	583	795	7850	0	0	0
145.0	1	196	237	3925	0	1160	371
147.0	1	147	1147	3925	0	0	0
149.0	1	220	287	0	0	0	0
151.0	1	253	739	0	0	1160	371
153.0	3	504	910	0	0	0	0
155.0	1	155	50	0	0	0	0
157.0	1	147	473	0	0	2319	742
159.0	0	0	659	0	0	1160	371
161.0	5	820	252	0	0	0	0
163.0	1	248	1334	0	0	0	0
165.0	1	113	151	0	0	1160	371
167.0	1	239	403	0	0	0	0
169.0	2	260	151	0	0	0	0
171.0	1	98	50	0	0	1160	371
173.0	0	0	538	0	0	0	0
175.0	1	203	0	0	0	0	0
Total	168	29247	91658	442506	371349	133236	42645

Appendix Table 4.– Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1971.

Midpoint length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
37.0	0	1428	0	0	0
39.0	0	714	763	0	0
41.0	0	2496	11530	8309	2802
43.0	0	636	17676	15805	4987
45.0	1421	2183	11668	15071	4397
47.0	2131	5895	13291	10639	2903
49.0	710	7621	8928	4472	1166
51.0	0	3293	5066	809	273
53.0	4972	4046	4541	443	149
55.0	12786	6158	9779	6901	273
57.0	9234	12972	14705	18291	347
59.0	2131	5729	14545	17261	0
61.0	710	1692	11865	3268	75
63.0	0	591	6899	1015	0
65.0	0	409	2853	0	0
67.0	0	758	1710	0	0
69.0	0	419	0	0	0
71.0	1421	1265	493	0	0
73.0	0	718	245	0	0
75.0	0	678	490	0	0
77.0	0	510	914	0	0
79.0	0	556	843	0	0
81.0	0	219	735	0	0
83.0	0	563	1162	0	0
85.0	0	1069	1299	0	0
87.0	0	1732	1391	0	0
89.0	0	1403	2384	0	0
91.0	0	2618	4553	0	0
93.0	0	1339	2028	0	0
95.0	0	3418	2718	7	35
97.0	0	5424	1604	14	71
99.0	0	4072	3106	28	142
101.0	0	7294	2911	28	142
103.0	0	8177	1773	69	354
105.0	0	4192	1813	35	177
107.0	0	4847	713	42	212
109.0	0	1952	133	42	212
111.0	0	568	870	14	71
113.0	0	129	307	21	106
115.0	0	224	381	7	35
117.0	0	0	0	35	177
119.0	0	100	0	7	35
121.0	0	371	381	0	0
123.0	0	469	381	0	0
125.0	0	1026	0	0	0
127.0	0	759	381	0	0
129.0	0	503	232	0	0
131.0	0	414	1144	0	0
133.0	0	1033	1244	0	0
135.0	109	721	0	0	0
137.0	0	865	763	0	0
139.0	0	282	100	0	0
141.0	219	306	813	0	0
143.0	656	59	0	0	0
145.0	437	273	50	0	0
147.0	1421	451	431	0	0
149.0	437	290	0	0	0
151.0	219	183	945	0	0
153.0	219	339	0	0	0
155.0	219	431	0	0	0
157.0	547	1064	381	0	0
159.0	109	195	0	0	0
161.0	328	473	0	0	0
163.0	109	156	0	0	0
165.0	328	480	0	0	0
167.0	0	90	0	0	0
169.0	109	37	0	0	0
Total	40982	121377	175931	102633	19141

Appendix Table 5.– Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1972.

Midpoint length (cm)	Number of fish by month						
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
35.0	0	0	2287	0	0	0	0
37.0	0	0	3045	960	0	0	149
39.0	0	2580	2462	0	0	0	149
41.0	0	0	2287	6715	0	8004	526
43.0	0	3893	3045	15300	8	25709	972
45.0	0	2580	5332	43939	8	7203	2379
47.0	0	0	2287	51155	1694	3910	2785
49.0	0	6473	12193	50626	20265	5619	1574
51.0	0	9053	8551	47229	2199	3109	79
53.0	0	19419	4910	35526	513	10590	680
55.0	0	63651	34264	24288	6295	12941	747
57.0	0	55959	25452	62227	31511	26213	1398
59.0	0	28471	19040	49289	33396	25956	1338
61.0	0	2580	3977	36288	26814	11899	905
63.0	0	0	1516	10628	36	5041	1959
65.0	0	0	3045	5551	27	3477	1930
67.0	0	0	0	3239	27	2230	2656
69.0	0	0	5332	55	62	5087	3643
71.0	0	0	0	28	54	4460	680
73.0	0	0	175	0	108	8920	1358
75.0	0	0	0	28	102	8431	1673
77.0	0	0	2934	0	903	3345	2125
79.0	0	0	2287	0	407	0	1337
81.0	0	0	472	0	0	0	1474
83.0	0	0	2759	2943	127	0	1416
85.0	0	0	1230	148	815	0	788
87.0	0	0	1888	28	1538	1115	0
89.0	0	0	1524	1602	1410	2362	0
91.0	0	0	2575	380	1284	1208	394
93.0	0	0	1413	7070	468	1115	0
95.0	0	0	1993	2608	1003	1115	0
97.0	0	0	4183	6096	1804	1468	867
99.0	0	0	5680	2261	1466	3227	0
101.0	0	0	6474	8864	4435	3852	316
103.0	0	0	6811	6475	2554	742	237
105.0	0	0	2979	12280	3666	3203	395
107.0	0	0	1171	9518	5015	3715	316
109.0	0	0	175	11637	5462	4875	552
111.0	0	0	469	4511	1745	5332	79
113.0	0	0	175	7699	1070	5512	0
115.0	0	0	758	3068	268	2485	0
117.0	274	0	0	543	14	2138	0
119.0	91	0	588	55	8	3631	0
121.0	639	0	1710	28	498	2270	0
123.0	365	0	1826	712	0	116	0
125.0	1461	0	766	120	498	116	0
127.0	1369	0	647	515	14	1115	0
129.0	1735	0	766	55	142	2231	0
131.0	1096	0	2651	2200	21	1691	0
133.0	639	0	882	1022	12	1188	38
135.0	183	0	472	6931	23	2044	0
137.0	639	0	175	802	32	2620	113
139.0	183	0	766	2159	24	2677	0
141.0	0	0	0	1698	29	2411	0
143.0	183	0	0	609	6	569	192
145.0	0	0	0	570	3	280	189
147.0	91	0	0	1452	9	747	76
149.0	0	0	0	1255	4	475	113
151.0	91	0	294	1448	3	266	113
153.0	0	0	294	625	0	0	38
155.0	0	0	0	326	0	0	76
157.0	0	0	0	1649	3	266	189
159.0	0	0	0	850	0	0	151
161.0	0	0	0	375	3	266	227
163.0	91	0	294	2450	0	0	151
165.0	0	0	0	464	0	0	113
167.0	0	0	0	686	0	0	76
169.0	0	0	0	457	0	0	76
171.0	0	0	0	878	0	0	38
173.0	0	0	0	83	0	0	0
175.0	0	0	0	28	0	0	0
Total	9130	194659	199281	561304	159905	250587	39845

Appendix Table 6.– Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1973.

Midpoint Length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
39.0	93	4117	0	0	0
41.0	93	3937	1702	0	0
43.0	93	1372	6020	0	0
45.0	93	1372	2461	570	0
47.0	93	0	1838	285	0
49.0	0	0	1086	0	0
51.0	93	1372	443	0	0
53.0	374	6682	0	0	0
55.0	187	7874	344	0	0
57.0	374	14736	1439	0	0
59.0	654	9426	4687	0	0
61.0	374	16467	7773	285	0
63.0	374	6264	8116	0	0
65.0	93	8233	5791	856	0
67.0	0	1372	1131	0	0
69.0	0	2744	1131	285	0
71.0	0	1372	480	570	0
73.0	0	775	0	856	0
75.0	187	775	272	285	0
77.0	187	0	0	856	0
79.0	187	0	0	856	0
81.0	187	775	0	285	0
83.0	467	0	0	285	0
85.0	93	775	0	1141	0
87.0	93	0	0	285	0
89.0	187	775	0	781	0
91.0	0	0	959	736	0
93.0	93	775	0	285	0
95.0	0	775	0	1186	0
97.0	0	1549	480	1306	0
99.0	0	3873	959	1021	0
101.0	0	4648	959	736	1624
103.0	0	10845	480	901	2706
105.0	0	1549	0	0	1624
107.0	0	6438	0	1186	1082
109.0	286	775	0	165	2165
111.0	0	0	0	736	4871
113.0	0	0	0	165	5953
115.0	143	775	0	1488	3247
117.0	0	775	0	1323	2165
119.0	0	0	0	1488	541
121.0	429	0	959	662	0
123.0	428	775	0	165	541
125.0	1143	0	0	0	0
127.0	1428	0	0	165	0
129.0	1571	0	0	165	541
131.0	1001	0	0	0	0
133.0	1571	775	0	165	0
135.0	1858	775	0	0	0
137.0	1001	0	0	0	0
139.0	572	0	0	0	0
141.0	1144	1549	0	0	0
143.0	428	0	0	0	0
145.0	429	0	0	0	0
147.0	143	0	0	0	0
149.0	143	0	0	0	0
151.0	143	0	0	0	0
153.0	285	0	0	0	0
155.0	0	0	0	0	0
157.0	0	0	0	0	0
159.0	0	0	0	0	0
161.0	0	0	0	0	0
163.0	143	0	0	0	0
Total	18958	127866	49510	22525	27060

Appendix Table 7.—Estimated length composition of yellowfin tuna caught by American purse seiners in the eastern tropical Atlantic in 1974.

Midpoint Length (cm)	Number of fish by month									
	Jan.	Feb.	Mar.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
35.0	0	0	0	0	0	87	33	540	0	0
37.0	0	0	0	0	0	87	0	0	0	0
39.0	0	0	0	0	0	745	132	2609	0	0
41.0	142	16	52	139	1893	174	33	540	1420	0
43.0	189	21	69	186	2524	793	0	0	5181	0
45.0	241	27	89	237	3218	928	66	1080	5430	0
47.0	73	8	27	72	978	1089	66	1080	1420	0
49.0	147	16	54	144	1956	875	99	1844	1420	0
51.0	121	13	44	118	1609	875	66	1753	1828	0
53.0	525	58	193	516	7003	349	66	1304	0	0
55.0	503	56	185	495	6719	1525	0	224	355	0
57.0	603	67	221	592	8044	2854	33	540	1118	0
59.0	366	41	135	360	4890	3734	66	2426	0	0
61.0	262	29	96	258	3502	2298	199	6606	4105	0
63.0	168	19	62	165	2240	770	298	9348	8024	0
65.0	73	8	27	72	978	652	199	7055	19749	0
67.0	73	8	27	72	978	910	33	1438	24512	0
69.0	0	0	0	0	0	257	33	540	8541	0
71.0	143	16	52	140	1906	201	33	764	3684	0
73.0	191	21	70	187	2544	772	0	0	8431	0
75.0	143	16	52	140	1906	1311	0	0	11579	0
77.0	96	11	35	94	1276	1218	0	0	6009	0
79.0	111	12	41	110	1488	2088	0	224	1766	0
81.0	118	13	43	116	1572	1141	296	4818	1105	0
83.0	276	31	102	272	3689	688	127	2065	760	0
85.0	138	15	51	136	1845	0	42	688	1901	0
87.0	290	32	107	285	3872	457	380	6194	380	0
89.0	274	30	101	269	3659	1028	253	4578	0	0
91.0	65	7	24	64	874	1336	211	3666	344	0
93.0	18	2	7	18	243	457	253	4578	0	0
95.0	16	2	6	16	213	201	42	688	0	0
97.0	32	4	12	31	425	288	0	0	0	0
99.0	34	4	13	34	455	370	42	688	355	235
101.0	138	15	51	136	1847	1208	42	913	344	0
103.0	65	7	24	64	874	1226	0	449	355	118
105.0	0	0	0	0	0	1378	0	449	355	118
107.0	236	26	87	232	3155	989	42	913	355	118
109.0	280	31	103	276	3744	2122	42	688	710	118
111.0	358	40	132	352	4785	3833	0	0	0	118
113.0	298	33	110	293	3979	2811	42	688	344	118
115.0	147	16	54	144	1956	4671	0	224	0	470
117.0	95	11	35	93	1262	4299	42	1137	0	353
119.0	139	15	51	136	1852	4800	108	2441	0	705
121.0	63	7	23	62	844	3131	0	1085	0	235
123.0	63	7	23	62	844	3232	33	1699	355	235
125.0	26	3	10	26	347	990	0	2468	355	353
127.0	50	6	18	49	661	87	33	3568	0	235
129.0	16	2	6	16	213	594	66	2239	0	235
131.0	18	2	7	18	243	663	42	688	355	0
133.0	0	0	0	0	0	707	0	374	0	118
135.0	2	0	1	2	30	292	0	187	355	0
137.0	5	1	2	4	61	436	42	1473	0	0
139.0	23	3	8	22	303	349	0	187	0	0
141.0	2	0	1	2	30	262	42	875	0	118
143.0	25	3	9	25	334	518	84	1750	0	0
145.0	20	2	8	20	273	493	0	187	0	353
147.0	18	2	7	18	243	349	0	0	0	470
149.0	5	1	2	4	61	117	0	411	0	705
151.0	14	2	5	13	182	466	0	0	0	0
153.0	11	1	4	11	152	292	0	0	0	235
155.0	5	1	2	4	61	0	0	224	0	0
157.0	11	1	4	11	152	174	0	0	0	0
159.0	0	0	0	0	0	0	0	0	0	0
161.0	9	1	3	9	121	0	0	0	0	118
163.0	5	1	2	4	61	87	0	0	0	0
165.0	2	0	1	2	30	0	0	0	0	0
167.0	5	1	2	4	61	0	0	0	0	0
169.0	5	1	2	4	61	0	0	0	0	0
171.0	0	0	0	0	0	0	0	0	0	0
173.0	2	0	1	2	30	0	0	0	0	0
Total	7592	845	2795	7458	101351	71134	3761	93195	123300	5881

ndix Table 8.— Estimated length composition of skipjack una caught by American purse seiners in the eastern tropical Atlantic in 1968.

Midpoint Length (cm)	Number of fish by month			
	Aug.	Sept.	Oct.	Nov.
9.0	0	0	2409	0
1.0	0	0	0	0
43.0	0	9257	2409	0
45.0	32798	70624	12046	0
7.0	131436	139866	68875	452
9.0	123675	91380	25709	362
1.0	28540	39476	22903	543
53.0	58833	21281	11452	271
55.0	45815	19055	27127	814
7.0	26035	28488	24718	814
9.0	25036	36659	11254	362
1.0	1752	34206	19900	814
63.0	0	9901	2211	90
65.0	1752	1076	0	0
al	475672	501269	231013	4522

Appendix Table 9.— Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1969.

Midpoint length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
39.0	0	4739	1048	0	0
41.0	0	18759	7150	0	0
43.0	22468	51955	14148	2013	872
45.0	17653	57873	26569	5965	2617
47.0	17653	96038	25620	15956	7414
49.0	8024	65096	24959	32961	3489
51.0	4815	73737	24851	45359	2617
53.0	1605	147494	49613	48242	2181
55.0	4815	157306	54574	63066	2181
57.0	1605	91651	57854	59256	436
59.0	1605	54032	34425	46465	0
61.0	0	33216	15788	34248	0
63.0	0	7631	1925	10974	0
65.0	0	1431	0	2259	0
Total	80243	860958	338524	366764	21807

Appendix Table 10.— Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1970.

Midpoint length (cm)	Number of fish by month						
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
37.0	0	0	0	24835	0	0	0
39.0	0	0	4943	0	0	0	0
41.0	70	2446	12334	24835	32939	11349	0
43.0	548	19219	39089	149012	16469	11242	3355
45.0	2610	91520	135299	311362	0	2476	1492
47.0	2761	96812	206739	301012	41173	32304	10918
49.0	2128	74613	91742	442347	151716	75504	13999
51.0	1259	44155	67015	381942	170979	87829	17427
53.0	737	25827	35296	250967	218438	128026	31797
55.0	426	14935	14286	41588	121571	123720	49316
57.0	525	18418	7986	56027	87236	115101	51251
59.0	162	5666	8398	0	17866	46369	24234
61.0	391	13692	13004	0	0	2141	1290
63.0	114	3983	1844	0	0	0	0
65.0	177	6212	0	0	0	0	0
67.0	108	3789	0	0	0	0	0
Total	12016	421287	637975	1983927	858387	636061	205079

Appendix Table 11.– Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1971.

Midpoint length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
35.0	0	778	0	3879	0
37.0	0	1054	13973	10622	0
39.0	1715	1969	79921	87724	22140
41.0	5358	2552	423894	572735	27721
43.0	37829	11730	601535	591718	99537
45.0	80052	62618	921515	389419	135261
47.0	47581	94475	612368	533072	126521
49.0	18539	91279	361004	220877	120755
51.0	14683	97721	384174	313773	57679
53.0	4394	68150	155941	355220	54889
55.0	6109	25970	70307	236933	32933
57.0	0	10751	21632	90572	10978
59.0	0	2250	19227	20129	0
61.0	1715	1969	4787	0	0
63.0	0	0	3722	0	0
65.0	1715	864	0	0	0
Total	219690	474130	3674000	3426673	688414

Appendix Table 12.– Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1972.

Midpoint length (cm)	Number of fish by month						
	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
33.0	0	0	2275	0	0	0	1290
35.0	2659	4106	42896	11985	0	8569	9871
37.0	5548	4646	44684	305230	100456	64367	70298
39.0	13525	13833	56322	497974	244828	206845	54401
41.0	22888	27127	64237	335621	391793	233145	33312
43.0	46122	50895	89352	231361	277366	109356	15386
45.0	63232	38305	278838	367061	300561	128683	14973
47.0	29478	86480	268123	279298	301074	179767	26969
49.0	2659	57565	126408	173796	111142	165454	26809
51.0	10636	61671	19085	59862	42428	113891	16855
53.0	2774	23297	22120	8954	30863	83770	11305
55.0	1387	4106	13263	2383	7122	27694	5450
57.0	0	14373	2275	9277	4748	15051	27
59.0	1387	8484	19586	0	0	3372	0
61.0	0	2323	26671	1711	0	2984	0
63.0	0	0	9360	0	0	0	0
Total	202295	397211	1085495	2284513	1812381	1342948	286946

Appendix Table 13.— Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1973.

Midpoint length (cm)	Number of fish by month				
	Jul.	Aug.	Sept.	Oct.	Nov.
33.0	126	3696	0	0	0
35.0	114	3340	0	5663	0
37.0	2151	62958	26879	3935	0
39.0	5594	163760	147907	21511	0
41.0	16286	476786	688219	185781	0
43.0	28982	848494	1392101	317625	0
45.0	31955	935517	2028754	478645	0
47.0	24474	716497	1518342	630823	1108
49.0	13104	383647	706955	388533	1582
51.0	3372	98730	133770	177279	4021
53.0	423	12382	11543	45677	5748
55.0	206	6024	0	2819	7422
57.0	299	8747	9252	0	4800
59.0	0	0	0	0	1399
61.0	68	1998	0	0	291
Total	127154	3722576	6663722	2258291	26371

Appendix Table 14.— Estimated length composition of skipjack tuna caught by American purse seiners in the eastern tropical Atlantic in 1974.

Midpoint Length (cm)	Number of fish by month									
	Jan.	Feb.	Mar.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
29.0	0	0	0	0	0	0	22682	0	0	0
31.0	0	0	0	0	0	0	56705	0	0	0
33.0	0	0	0	0	0	443	56705	0	0	0
35.0	0	0	0	0	0	0	317157	0	0	0
37.0	214	15	116	282	2002	0	458035	9524	0	8228
39.0	2399	174	1304	3164	22462	19659	425648	11547	6739	38798
41.0	6191	448	3365	8164	57965	38702	767286	415456	25499	207593
43.0	6602	478	3588	8705	61805	121033	680598	631623	75404	236729
45.0	5710	414	3103	7529	53455	102638	455170	208315	69577	260544
47.0	17511	1268	9517	23091	163939	102108	507089	300723	65934	243426
49.0	6597	478	3585	8699	61760	74915	262163	128828	115659	123428
51.0	11755	851	6389	15501	110056	105090	172428	27220	72673	55381
53.0	1254	91	682	1654	11743	30830	437149	0	26957	31378
55.0	264	19	144	348	2472	18203	502969	0	47175	27108
57.0	950	69	516	1252	8892	12519	318003	0	6739	22506
59.0	963	70	524	1270	9018	10518	118255	0	6739	12866
61.0	0	0	0	0	0	5786	44346	0	0	0
63.0	97	7	53	128	908	2384	14782	0	0	0
65.0	963	70	524	1270	9018	795	0	0	0	0
67.0	915	66	497	1206	8564	0	0	0	0	0
Total	62385	4518	33907	82263	584059	645623	5617170	1733236	519095	1267985

Appendix Table 15.— Estimated length composition of bigeye tuna caught by American purse seiners in the eastern tropical Atlantic.

Midpoint Length (cm)	Number of fish by year				
	1968	1971	1972	1973	1974
39.0	0	0	0	70	126
41.0	0	315	0	140	478
43.0	22	567	0	0	353
45.0	0	158	0	0	364
47.0	0	166	0	0	655
49.0	0	329	0	0	496
51.0	0	0	204	140	227
53.0	0	175	392	71	642
55.0	0	175	1794	211	914
57.0	0	1032	2390	493	787
59.0	0	1449	5163	1262	581
61.0	22	175	8116	1546	2372
63.0	0	420	3972	848	2517
65.0	0	646	1191	992	2187
67.0	44	158	400	284	792
69.0	22	472	0	284	1342
71.0	22	154	0	0	943
73.0	0	158	0	0	624
75.0	0	235	0	140	844
77.0	0	88	0	213	738
79.0	0	0	0	210	304
81.0	0	0	0	281	738
83.0	0	79	196	70	1477
85.0	22	0	204	282	1463
87.0	44	77	604	421	2070
89.0	44	158	400	417	643
91.0	0	79	799	701	867
93.0	0	312	791	566	1240
95.0	22	235	1574	142	661
97.0	0	471	196	142	204
99.0	0	548	196	71	325
101.0	0	236	587	0	394
103.0	0	315	0	0	482
105.0	0	166	0	71	238
107.0	0	245	0	0	41
109.0	0	235	0	0	755
111.0	0	465	0	71	430
113.0	26	954	0	0	1624
115.0	26	469	0	71	1028
117.0	26	940	0	0	1186
119.0	0	1656	0	71	803
121.0	26	1179	0	0	388
123.0	0	866	0	0	364
125.0	26	630	0	71	172
127.0	26	550	0	71	107
129.0	0	235	196	0	107
131.0	26	0	0	0	41
133.0	26	77	0	0	705
135.0	26	0	0	0	315
137.0	0	0	0	0	344
139.0	0	77	0	0	41
141.0	0	0	0	0	587
143.0	0	158	0	71	376
145.0	0	0	0	71	842
147.0	0	156	0	71	270
149.0	0	79	0	0	1079
151.0	0	232	0	0	0
153.0	0	77	0	0	235
155.0	0	232	0	0	0
157.0	26	0	0	0	0
159.0	0	154	0	0	0
161.0	0	154	0	0	41
163.0	0	0	0	0	0
165.0	0	77	0	0	0
167.0	0	154	0	0	0
169.0	0	0	0	0	0
171.0	0	88	0	0	270
Total	524	19687	29365	10636	41239

☆ U. S. GOVERNMENT PRINTING OFFICE: 1976—697-8

NOAA Technical Report NMFS SSRF-702

Length Composition of Yellowfin, Skipjack, and Bigeye Tunas Caught in the Eastern Tropical Atlantic by American Purse Seiners

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August 1976

U.S. DEPARTMENT OF COMMERCE
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Length Composition of Yellowfin, Skipjack, and Bigeye Tunas Caught in the Eastern Tropical Atlantic by American Purse Seiners

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ABSTRACT

Sampling and analytical procedures that are used to estimate the size composition of Atlantic tunas caught by American purse seiners in the eastern tropical Atlantic are described. The procedures are based on a stratified, two-stage subsampling model. Estimates indicated that about 0.2 to 1.4 million yellowfin tuna, *Thunnus albacares*, 1.2 to 12.8 million skipjack tuna, *Katsuwonus pelamis*, and 0.5 to 41.2 thousand bigeye tuna, *T. obesus* were caught annually by the fleet in 1968-74. The dominant age group in most years was 1-yr olds for yellowfin and skipjack tuna and 2-yr olds for bigeye tuna.

INTRODUCTION

United States participation in the eastern tropical At- tuna fishery off west Africa began in the 1950's. It ot until 1967, however, that significant numbers of S. purse seiners entered the fishery (Sakagawa and narz 1972; Sakagawa 1974). Since then as many as 36 ican[3] seiners have participated annually in the y.

The American tuna fleet that fishes in the eastern At- tic consists primarily of purse seiners of 80 to 1,800 c tons carrying capacity of fish. Home bases for vessels are in California and Puerto Rico; the tern Atlantic is only one of several areas where the s fish in a year. Each seiner has upwards of 20 fish- ng wells that freeze and store an average of about 60 tric tons of tuna per well.

The fishing season in the eastern tropical Atlantic, year round for most fleets, begins about July and y ends in November-December for most American sels. The American vessels generally fish in close ximity to each other, although they are operated by endent captains. Their catch consists of yellowfin, *nus albacares*, and skipjack, *Katsuwonus pelamis*, as primarily and some bigeye tuna, *T. obesus*, and in- ental catches of little tunny, *Euthynnus alletteratus*, e and bullet mackerels, *Auxis* spp., and rainbow r, *Elagatis bipinnulata*. In 1967-69, more than half catch was yellowfin tuna; since 1969, skipjack tuna has been the dominant species in the catch (Sakagawa and Lenarz 1972). Virtually all the U.S. catch is returned to the United States aboard the seiners or aboard transshipment vessels for processing, canning, and marketing. Transshipments were made in 1970-74.

Monitoring of the American catch to assess stock abundance was initiated by the National Marine Fisheries Service (NMFS), NOAA, in 1968 and continued annually since then. Catch, effort, and length-frequency samples are collected by NMFS representatives and under contract by the Inter-American Tropical Tuna Commission (IATTC) representatives. Summaries of catch and effort data were reported in Sakagawa and Lenarz (1972) and Sakagawa (1974). This report presents a description of procedures used to estimate the length composition of tunas in the American catch and the estimated length composition of tunas caught in 1968-74.

SAMPLING PROCEDURES

Tuna catches were sampled for length-frequencies aboard the seiners during unloadings at canneries in California and Puerto Rico in 1968-74, and during unloadings at freezer storage facilities and onto transshipment vessels in west Africa in 1971-73. Samples were also obtained from transshipment vessels that unloaded at canneries in California and Puerto Rico.

Sampling in west Africa was particularly critical in 1971 because in that year, and in 1970 to a lesser degree, large yellowfin and bigeye tunas with presumably high mercury content were selectively shipped to Europe, where a higher mercury content was acceptable, rather than to the United States. Samples taken only in California and Puerto Rico in those years were therefore biased.

Sampling in west Africa also presented the opportunity of sampling the transshipped catch before it was mixed in the holds of the transshipment vessels. Upwards of 700 metric tons of fish have been transported in

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he fishing operations of Canadian, Dutch (based in Willemstad, herlands Antilles), Panamanian, and U.S. boats fishing in the eastern Atlantic are monitored as a unit by the Inter-American Tropical ommission. "American" in this report refers to this fleet, which in -73 consisted of at least 83% U.S. seiners.

a hold of a transshipment vessel. The transshipped catches of individual seiners are kept separate, but an entire seiner's catch, which is usually caught in several areas and over several months, is generally loaded into a single hold.

Length-Frequency Samples

The sampling procedures were virtually the same as those recommended by Hennemuth (1957) for the eastern tropical Pacific fishery, i.e., a stratified, by area and month, two-stage subsampling procedure (Cochran 1963) was used. The boundaries of the areas (Fig. 1) were drawn according to the distribution and concentration of fishing effort of the American fleet.

The first stage of the sampling was to choose the well (or hold if a transshipment vessel[4]) to sample. The second stage was to draw from the selected well a random sample of each species (yellowfin, skipjack, and bigeye tunas). Ancillary information, such as well number and catcher vessel name, was recorded for each sample. The date, location (NMFS area — Fig. 1), and tonnage of the catch sampled were obtained from logbooks after the samples were drawn.

Before 1972, samples were obtained on an opportunistic basis and the sample size varied (10 to 300 fish). Since 1971, a goal of 6 skipjack samples and 12 yellowfin samples of 50 fish each from each NMFS area and each fishing month was established in an attempt to ensure a more complete area-month coverage. The larger number of samples for yellowfin tuna was required because of the greater variability in sizes of this species (Hennemuth 1957). This goal, however, was not attained in any of the years.

Total Catch by NMFS Area-Month

Total catch, by species and month, of tunas caught in the Atlantic by American vessels is tabulated annually by the IATTC from landing receipts. Logbook information on estimated catch by species, 1° area, date, and well number in which the catch is stored for each net set is also collected by the IATTC from virtually the entire American fleet. This logbook information was used to identify those seine sets that contributed to the catch in wells that were sampled and also to prorate the total catch by species of the entire fleet into catch by NMFS area-month strata.

ANALYTICAL PROCEDURES

Different areas apparently contain different sizes of fish, at least for yellowfin tuna in the eastern tropical Atlantic (International Commission for the Conservation of Atlantic Tunas 1974a), and the stratified sampling procedure, by month and area, was designed to account partly for this difference. Sizes of fish in the total

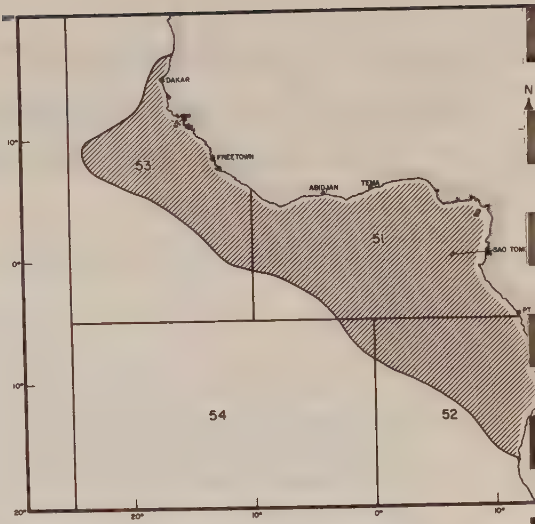

Figure 1.—Map of the eastern tropical Atlantic where An seiners fish for tropical tunas (shaded area). Numbered sta areas used in this report are shown.

American catch were estimated from the str length-frequency samples and catch.

When a sample is drawn from a well, complete mation on date, location, and tonnage of catch is ways available; complete information is obtaine from the ship's logbook. Fish that may have been c in different strata were, consequently, sometimes in a single sample. These samples were not used analysis unless 75% or more of the tonnage in th was caught in a single NMFS area-month str Because of this rule, virtually all samples from shipment vessels were not used in this study. An currently underway which contain a special stratu transshipment samples may lead to new procedu utilizing much of the rejected samples.

Weighting Factor

The sample size was fixed and not proportional numbers of fish in the well. Each sample was th weighted by a factor (number of fish) based species tonnage and average weight of fish in the when this was unavailable, on the species tonna average weight of fish in seine sets that contribu the catch in the sampled well.

Substituting Samples

Samples were unavailable for all area-month st which the fleet caught fish. For strata without sam was necessary to make assumptions about the cat substitute samples from adjacent strata, within estimate the sizes of fish caught by the fleet stitution was on the basis of the following rules: same month and adjacent areas; 2) use same ar adjacent months; 3) use adjacent months and a eas. These rules are ordered according to priority and based on the assumption that differences in sizes of from widely separated areas or months are greater n differences in sizes of fish from adjacent areas or onths.

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[4] It is not uncommon to find several species stored in a well. The fish are partially thawed in the wells before unloading at the canneries or onto a transshipment vessel. Measurements were made on partially thawed fish.

n Tables 1 and 2 the area-month strata with sub- uted samples are shown for yellowfin and skipjack as caught in 1968-74. About 20 to 60% of the strata in ich yellowfin tuna were caught and about 10 to 60% of strata in which skipjack tuna were caught had no ples and substitutes were necessary (Table 3). In ms of tonnage, substitutions were required for 2 to % of the total yellowfin tuna catch and 1 to 17% of the l skipjack tuna catch.

he poorest sampling coverage of yellowfin and skip- k tunas was in 1970. In that year, representative pling was difficult because large yellowfin and bigeye tunas were transshipped in west Africa to foreign ports and not sampled. The best sampling coverage, in terms of tonnage, was in 1969 for yellowfin and 1971 for skipjack tuna.

Estimating Length Composition of Catch

Length-frequency of fish in the total catch by species was computed by summing estimates for each area-month stratum. The following procedures were used for the stratum estimates:

1. The weight (w in kilograms) of each fish was estimated from length (l in centimeters) based on the appropriate length-weight equation (Lenarz 1974) shown below. The average weight ($\bar{w}_i$) of fish in the sample, $i = 1, 2, \ldots, k$, was then estimated.

Table 1.—Catch (metric tons) and number of length-frequency samples of yellowfin tuna by NMFS area-month strata. Samples substituted in strata without samples are identified in parentheses.

Month - year	Area 53		Area 51		Area 52	
	Catch (tons)	Samples	Catch (tons)	Samples	Catch (tons)	Samples
January 1974			88	(July-51)	9	(July-51)
February 1974			11	(July-51)		
March 1974			33	(July-51)	2	(July-51)
May 1970			4	(June-51)		
1972			363	1	11	(May-51)
June 1970			682	6	3	(June-51)
1972	21	(June-51)	613	2		
1974			95	(July-51)		
July 1969			605	1		
1970			1578	5		
1971			471	2		
1972	34	(July-51)	1676	5	51	(July-51)
1973			670	3		
1974			1292	5		
August 1968			1995	7		
1969			6786	8		
1970			3207	3		
1971	8	(Aug.-51)	1730	10		
1972	8	(Aug.-51)	3955	14	993	3
1973			369	(Aug.-52)	867	3
1974			1405	7	95	(Aug.-51)
September 1968			1384	3	1352	3
1969			5195	10	2	(Sept.-51)
1970	494	1	1769	(Sept.-53)		
1971			353	1	920	6
1972	20	(Oct.-53)	124	(Sept.-52)	1059	5
1973			9	(Sept.-52)	261	3
1974					51	(Oct.-52)
October 1968			143	1	953	(Oct.-51)
1969			3643	4	351	(Oct.-51)
1970	962	3	12	(Oct.-53)	597	(Oct.-53)
1971	8	1	93	2	179	1
1972	1665	4	943	4	176	(Oct.-51)
1973			405	2	7	(Oct.-51)
1974			647	2	836	2
November 1969			3178	4	1	(Nov.-51)
1970	36	(Oct.-53)	69	(Oct.-53)	398	(Oct.-53)
1971	41	(Oct.-53)	31	(Oct.-51)		
1972	344	4	28	1	18	(Nov.-51)
1973			706	1		
1974	28	(Nov.-51)	429	3	355	3
December 1974			191	1	53	(Dec.-51)

Table 2.—Catch (metric tons) and number of length-frequency samples of skipjack tuna by NMFS area-month strata. Samples substituted in strata without samples are identified in parentheses.

Month - year		Area 53		Area 51		Area 52	
		Catch (tons)	Samples	Catch (tons)	Samples	Catch (tons)	Samples
January	1974					133	(July-51)
February	1974			10	(July-51)		
March	1974			48	(July-51)	24	(July-51)
May	1970			29	(June-51)		
	1972			334	2		
June	1970			1007	5	11	(June-51)
	1972	130	(June-51)	703	3		
	1974	5	(July-51)	171	(July-51)		
July	1969			161	1		
	1970			1375	6		
	1971			423	2		
	1972	419	2	1504	4	121	(July-51)
	1973			214	(Aug.-52)		
	1974			1245	5		
August	1968			1206	2		
	1969			2443	14		
	1970			4441	3		
	1971			1119	9		
	1972	75	2	1465	9	1811	6
	1973			94	(Aug.-52)	6175	22
	1974			899	6	443	1
September	1968			1049	3	265	2
	1969			1011	9	1	(Sept.-51)
	1970	428	(Sept.-51)	1935	2		
	1971			402	1	6549	19
	1972	5	(Sept.-51)	701	2	2124	7
	1973			19	(Sept.-52)	11465	28
	1974					10796	10
October	1968			268	1	375	1
	1969			1071	5	155	(Oct.-51)
	1970	1087	3	4	(Oct.-53)	814	(Sept.-51)
	1971	46	(Oct.-51)	3155	6	3725	9
	1972	826	7	1180	7	379	2
	1973			56	(Oct.-52)	4189	13
	1974			308	1	2453	6
November	1968					15	(Oct.-52)
	1969			43	1	7	(Nov.-51)
	1970			23	(Oct.-53)	643	(Oct.-53)
	1971	218	1	1191	1		
	1972	382	5	34	(Nov.-53)	9	(Oct.-52)
	1973			82	2		
	1974	45	(Nov.-51)	275	1	810	1
December	1974			102	(Dec.-52)	2207	8

yellowfin tuna

$w = (2.18 \times 10^{-5})\, l^{2.970}$

skipjack tuna

$w = (5.61 \times 10^{-6})\, l^{3.315}$

bigeye tuna

$w = (1.25 \times 10^{-5})\, l^{3.121}$

2. Average weight was used to convert the well tonnage (S_i) from which the *i*th sample was taken to numbers of fish ($M_i = S_i/\bar{w}_i$).
3. M is distributed proportionately by 2-cm intervals, according to the length-frequency distribution o *i*th sample.
4. A weighted average weight ($\bar{\bar{w}}$) of fish in al samples of a stratum was estimated with M_i a weighting factor, $\bar{\bar{w}} = \Sigma(M_i \bar{w}_i)/\Sigma M_i$.
5. The number of fish (N) in the total catch (C) stratum was estimated with $N = C/w$.
6. The length-frequency distributions of all M_i's stratum were pooled and the pooled frequency tribution was used to estimate the length position of N.

Table 3.—Sampling coverage of NMFS area-month strata in which yellowfin and skipjack tunas were caught by American tuna seiners in 1968-74.

Species-year	Area-month strata[1]			Catch			Samples	
	Total	Sampled		Total	Sampled		Total	Number/
	(number)	Number	Percent	(tons)	Tons	Percent	(number)	Catch of 1,000 tons
Yellowfin								
1968	5	4	80.0	5,830	4870	83.8	14	2.40
1969	8	5	62.5	19,760	19,410	98.2	27	1.37
1970	13	5	38.5	9,810	6,920	70.6	18	1.83
1971	10	7	70.0	3,830	3,750	97.9	51	13.31
1972	19	10	52.6	12,100	11,640	96.2	43	3.55
1973	8	5	62.5	3,300	2,910	88.3	12	3.64
1974	17	7	41.2	5,620	5,160	91.7	28	5.00
Skipjack								
1968	6	5	83.3	3,180	3,160	99.5	9	2.83
1969	8	5	62.5	4,890	4,730	96.7	31	6.34
1970	12	5	41.7	11,790	9,840	83.5	19	1.61
1971	9	8	88.9	16,830	16,780	99.7	59	3.51
1972	18	13	72.2	12,200	11,900	97.6	58	4.75
1973	8	4	50.0	22,290	21,910	98.3	67	3.01
1974	17	9	52.9	19,970	19,440	97.3	39	1.95

[1] Only strata in which a catch was made are included.

ESTIMATES OF LENGTH COMPOSITION OF CATCHES

Yellowfin Tuna

The estimated length compositions of yellowfin tuna in the 1968-74 catches by month strata, all areas combined, are shown in Appendix Tables 1 to 7. Area differences are presumed to be not as significant as monthly differences within a year.

As many as four modal groups are found in the length-frequency distributions, but only two or three are prominent (Fig. 2). The prominent modes correspond to the apparent entering year class (approximately 33 to 47 cm long), 1-yr-old (48 to 85 cm long), and 2-yr-old (86 to 123 cm long) fish. The modal size of the apparent entering year class is peculiar in that it differs from the modal size of the 1-yr-old fish by about 18 cm. According to the growth curve for Atlantic yellowfin tuna of Le Guen and Sakagawa (1973), the difference should be about 57 cm if the two groups are 1 yr apart. Some possible causes for this difference are: 1) there is extreme sampling bias of the entering year class, and perhaps even of 1-yr-old fish in the catch, owing to differential availability or vulnerability; 2) the entering year class in fact represents slower growing or later hatching fish of the same year class as the 1-yr-old fish, i.e., from multiple spawnings (Richards 1969); or 3) that the growth curve of Le Guen and Sakagawa (1973) is incorrect. Both 1) and 2) are probably the major causes for the difference. Hennemuth (1961) similarly identified length modes that were less than a year apart in age and presumably from identical year classes or subpopulations of yellowfin tuna from the eastern tropical Pacific.

In 1968-74, about 0.2 to 1.1 million yellowfin tuna were caught annually by the American fleet in the eastern tropical Atlantic. The age-frequency distributions of the catches (Table 4), based on analysis of modal progression and the growth curve of Le Guen and Sakagawa (1973), indicate that the dominant age group was 1-yr-old fish in 1968 and 1970-74, and 2-yr-old fish in 1969.

The catch of 1969 is unusual compared to that of the other years. Besides the dominance of 2-yr olds in the catch of that year, the 1969 catch (in weight) of yellowfin tuna was the highest recorded for the American fleet and virtually all (98%) was taken in NMFS area 51. About 90% of the catch, furthermore, was from pure yellowfin schools, the remainder from mixed yellowfin-skipjack schools. In the other years, a smaller percentage (61 to 75%) of yellowfin tuna was caught in area 51 and only about 60% of the catch was from pure yellowfin schools. Yellowfin tuna in mixed yellowfin-skipjack schools are generally smaller than in pure yellowfin schools

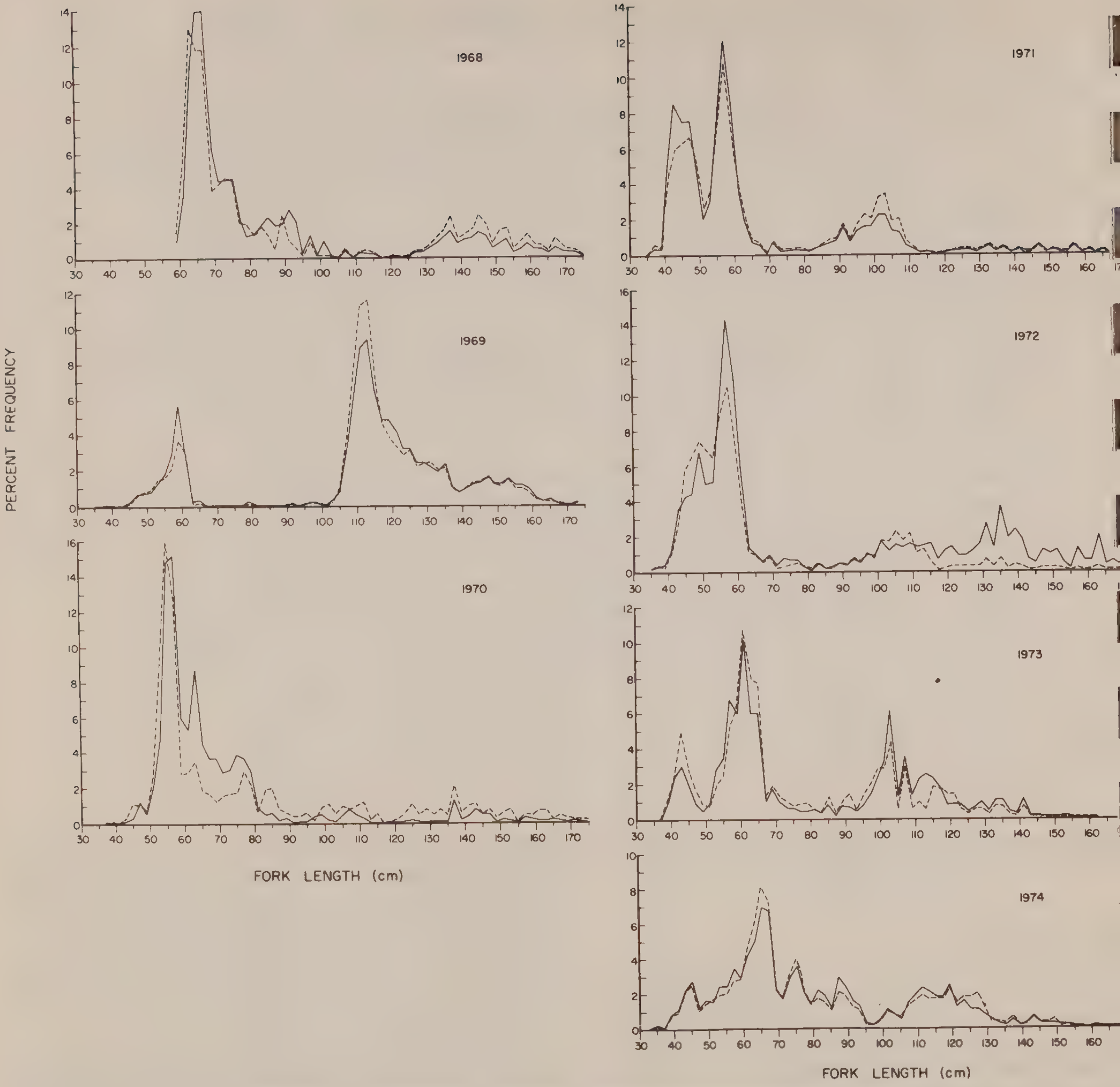


Figure 2.—Estimated length composition of yellowfin tuna caught by American seiners in the eastern tropical Atlantic, 1968-74. (Solid lin stratified procedure; dashed line — unstratified procedure.)

(Calkins 1965). The predominance of large yellowfin tuna (>100 cm) in the 1969 catch could have been caused therefore by the high percentage of pure schools fished in that year.

Skipjack Tuna

The catch of skipjack tuna by the American fleet markedly increased from 3,180 metric tons in 1968 to 22,290 metric tons in 1973, then decreased to 19,970 metric tons in 1974 (Table 3). This represents for skipjack tuna an estimated 1.2 million in 1968, 12.8 million in 1973, and 10.6 million in 1974. The estimated len composition of the 1968-74 catches by month strata, areas combined, are shown in Appendix Tables 8 to

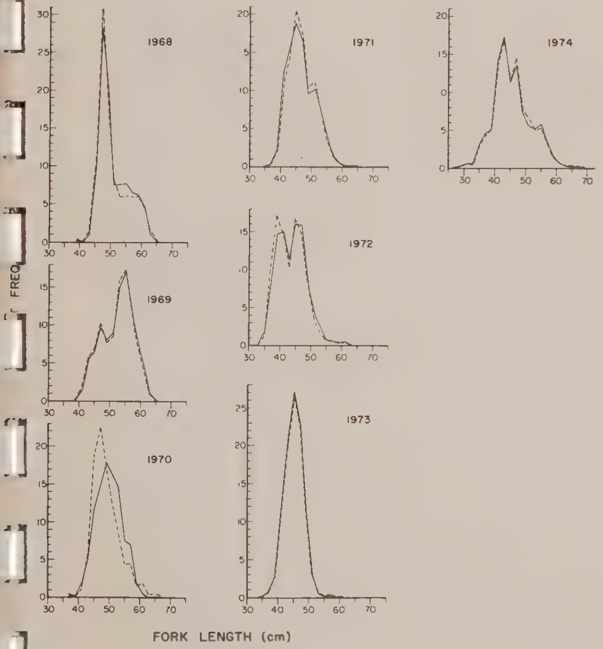
Two apparent age groups, probably 1-yr-old (31 t cm long) and 2-yr-old (56 to 67 cm long) fish, tributed to the catch (Fig. 3). The dominant group wa yr-old fish in all years except 1969 (Table 5).

The dominant modal length in the skipjack ca decreased from about 50 to 55 cm in 1968-70 to abou cm in 1971-74 (Fig. 3). This decrease, while relati small, occurred with the discovery by the American f in 1971 that skipjack fishing is good off Angola (NM area 52) during the fall months. Before 1971 most of

Table 4.—Estimated age composition of yellowfin tuna caught by the American purse seine fleet in the eastern tropical Atlantic.

Age group	Approximate length (cm)	Estimated catch (numbers) by year						
		1968	1969	1970	1971	1972	1973	1974
0	35-51			29,900	169,100	368,300	25,200	46,700
I	52-91	230,300	116,900	907,500	186,600	763,600	122,000	157,800
II	92-125	54,200	339,600	63,000	81,100	218,500	82,700	99,500
III	126-149	16,400	142,900	77,700	16,300	46,600	15,300	99,800
IV	150-169	38,600	41,100	25,700	7,000	15,300	700	13,400
V+	170+	19,400	3,200	7,000		2,300		
Total		358,900	643,700	1,110,800	460,100	1,414,600	245,900	417,200

American catch was made in the Gulf of Guinea and only about 3 to 21% of the skipjack tuna was caught in area 52. Since the discovery in 1971, as much as 98% of the annual American catch of skipjack has been taken from area 52.



ure 3.—Estimated length composition of skipjack tuna caught by American seiners in the eastern tropical Atlantic, 1968-74. (Solid line — stratified procedure; dashed line — unstratified procedure.)

Bigeye Tuna

Bigeye tuna are not often available to the surface fisheries (purse seine and pole-and-line) of the eastern tropical Atlantic. This species is sometimes confused with yellowfin tuna and catches may have been included with yellowfin tuna catches, but the amount is probably small. The American fleet reported bigeye tuna catches only in 1968 and 1971-74. A few length-frequency samples were collected in those years (Table 6). Because the samples were few, estimates of the length composition of the catch were based on all samples combined without stratification, i.e., all catches and samples pooled and one estimate calculated for each year (Appendix Table 17).

About four major modal groups (39 to 51 cm, 52 to 73 cm, 74 to 105 cm, and 106 to 131 cm) can be identified in the length-frequency distributions (Fig. 4). These groups apparently represent age groups of 1 to 4 yr, based on

Table 5.—Estimated age composition of skipjack tuna caught by the American purse seine fleet in the eastern tropical Atlantic.

Age group	Approximate length (cm)	Estimated catch (numbers) by year						
		1968	1969	1970	1971	1972	1973	1974
I	31-55	802,800	531,000	4,268,700	6,413,700	7,290,200	12,754,800	9,327,500
II	56-67	409,700	1,137,300	486,000	2,069,200	121,600	43,300	1,222,800
Total		1,212,500	1,668,300	4,754,700	8,482,900	7,411,800	12,798,100	10,550,300

Table 6.—Catch and number of length-frequency samples of bigeye tuna caught by the American purse seine fleet in the eastern tropical Atlantic.

Year	Number of samples	Catch	
		Tons	Estimated Numbers
1968	2	15	500
1971	7	540	19,700
1972	3	210	29,400
1973	3	110	10,600
1974	8	860	41,200

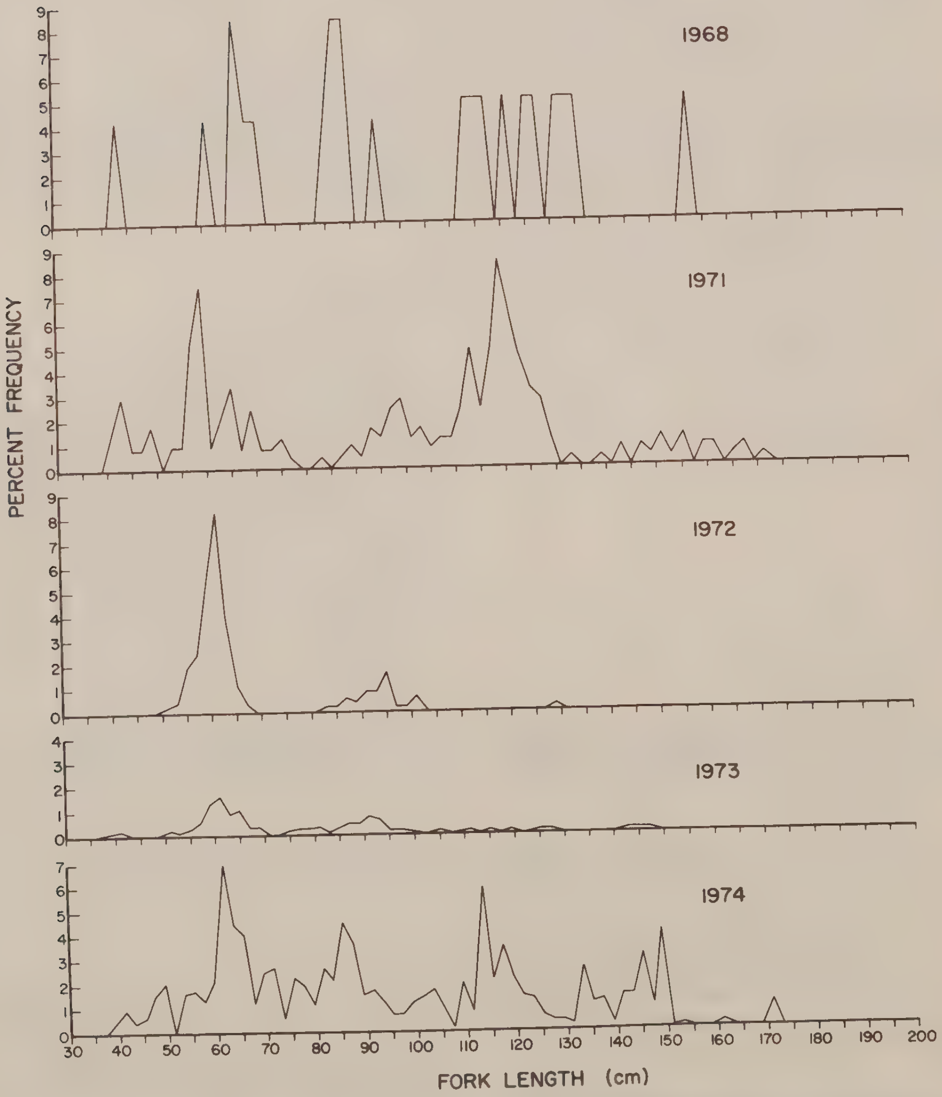


Figure 4.—Estimated length composition of bigeye tuna caught by American seiners in the eastern tropical Atlantic, 1968 and 1971-74.

Champagnat and Pianet's[5] growth curve for Atlantic igeye tuna.

The estimated total number of bigeye tuna caught by the American fleet in 1968 and 1970-74 ranges from about 500 to 41,200 fish. The largest catch was in 1974, the nallest in 1968.

SOURCES OF BIAS IN THE ESTIMATES

Several possible sources of bias in the sampling, eighting, and substitution procedures could have significantly influenced the estimated length-frequency distributions of the catches. Some of the sources are dis- ssed below.

Sampling Bias

Hennemuth (1957) found a slight size-depth ratification of skipjack tuna but none for yellowfin tuna in wells he examined. He mentioned that stratification could result from settling of large fish to the bottom of e well or from different schools of fish of different sizes packed in a layer fashion.

Early in our sampling program, size-depth stratification was recognized as a possible source of error and steps ere taken to reduce the influence of this error by imiting sampling to wells that did not appear to contain fish that were stratified by size and depth. How effective is measure was is not known.

A more serious sampling bias was introduced in 1970 with the discovery that tunas, particularly large specimens, contain high levels of mercury which the Food d Drug Administration of the United States deemed nacceptable for U.S. markets. Canneries in the United States, therefore, limited their purchases of large fish, and American fishermen were forced either to not land rge tunas or to sell the large tunas to foreign markets where the acceptable level of mercury contamination was higher. Because large yellowfin and bigeye tunas caught f Africa in 1970 and 1971 were selectively sold and ansshipped from west African ports directly to foreign buyers, fish landed in the United States were biased towards the smaller fish. This bias probably affected our timates for 1970. Estimates for 1971 were not affected cause catches transshipped to foreign ports were sampled in west African ports prior to transshipment.

eighting Bias

Some of our length-frequency samples were weighted by a factor (number of fish) based on the total tonnage d average weight of fish in sets that contributed to the tch in the sampled well. As indicated earlier, this technique was used because the sample size was not proportional to the numbers of fish present and the amount of nnage in the well was not known. The use of the total nnage, instead of the tonnage in the sampled well only, to base a weighting factor introduced a bias of overweighting the samples. For example, a sample from a well containing 20 tons of fish from a 80-ton set A and 40 tons from a 40-ton set B would have a weighting factor based on 120 tons, causing the sample to be disproportionately weighted by the catch of set A.

We examined this bias with the August 1973 yellowfin tuna catch of area 52 (Table 1) in which the actual tonnages of fish in the three sampled wells were available. A biased estimate length composition of the catch was derived with weighting factors based on tonnages of 127, 41, and 17 for the three samples. An unbiased estimated length composition of the catch was derived with weighting factors based on the actual tonnages in the sampled wells of 60, 20, and 15, respectively. The unbiased and biased estimated length compositions of the catch are not very different (Fig. 5). However, the total estimated number of yellowfin tuna is 7% higher in the unbiased than in the biased estimate, owing to the greater numbers of small fish (<61 cm) in the unbiased estimate.

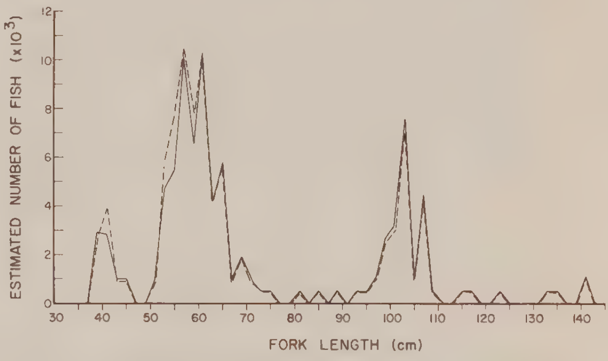


Figure 5.—Estimated length composition of yellowfin tuna caught in August 1973 in NMFS area 52. (Solid line — biased weighting factors; dashed line — unbiased weighting factors.)

Substitution Bias

Of all the possible sources of bias in our estimates, substitution bias perhaps is the most serious. As indicated earlier, 11 to 61% of the strata were not sampled and required substitution of samples from adjacent strata. Furthermore, not all of the sampled strata were sampled adequately. Between 20 to 43% of the strata sampled for yellowfin tuna and 0 to 33% of the strata sampled for skipjack tuna were sampled only once. These samples were also used in the substitution procedure, at times applied to a large catch (Table 7).

The effects of our substitution procedure and single samples on the estimated length composition of the catch were examined with the 1970 data. In that year, sampling coverage was poorest. In Figures 6 and 7, we show the estimated length composition by month using substitutions and also the portion of the composition derived from strata with two or more samples only. In general, the results indicate that substitutions affected

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Champagnat, C., and R. Pianet. Croissance du patudo (*Thunnus sus*) dans les regions de Dakar et de Pointe. Unpubl. manuscr., 7 p. Centre de Recherches Oceanographiques, B. P. 2241, Dakar, Senegal.

Table 7.—Number of NMFS area-month strata in which single samples were obtained or substituted.

Species - Year	Number of Strata[1]	Strata sampled once		Strata with one sample (including substitutions)	
		Number	Catch (tons)	Number	Catch (tons)
Yellowfin					
1968	5	1	140	2	1,100
1969	8	1	600	1	600
1970	13	1	490	2	2,260
1971	10	3	540	4	580
1972	19	2	390	4	420
1973	8	1	710	1	710
1974	17	1	190	2	260
Skipjack					
1968	6	2	640	3	660
1969	8	2	200	3	210
1970	12	0	0	0	0
1971	9	3	1,810	3	1,810
1972	18	0	0	0	0
1973	8	0	0	0	0
1974	17	4	1,840	5	1,880

[1] Only strata in which a catch was made are included.

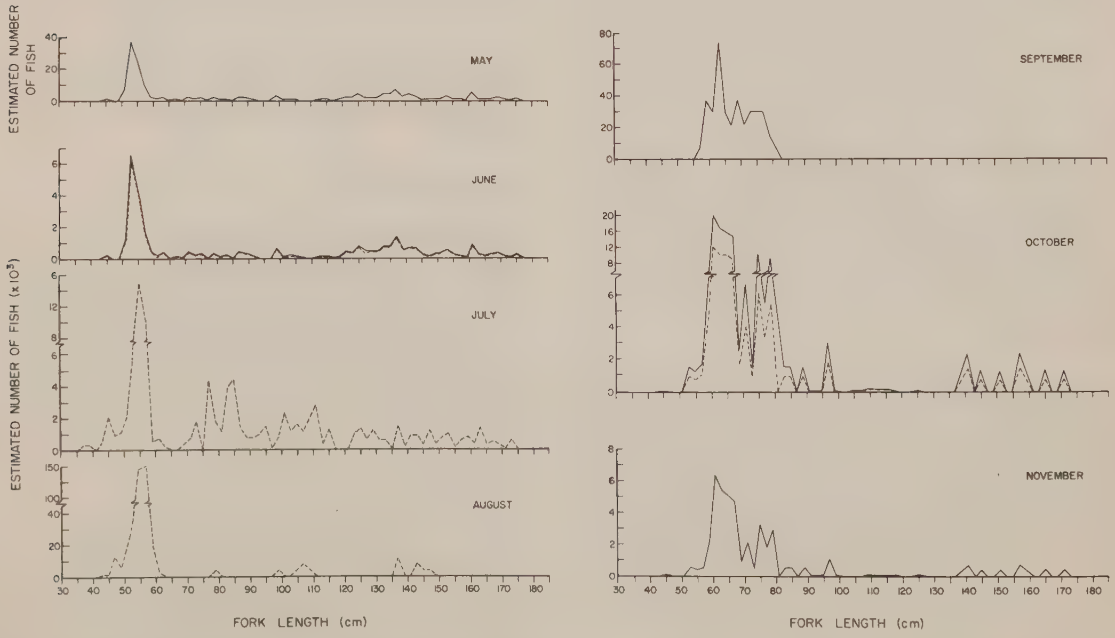


Figure 6.—Estimated length composition of yellowfin tuna by month caught by American seiners in 1970. (Solid line — stratified procedure w substituted samples; dashed line—stratified procedure without substituted samples and strata with one sample.)

collection averaged over both years are (number of lections in parentheses):

	Fall	*Winter*	*Spring*	*Summer*	*Overall*
f	4.25(12)	3.31(13)	4.92(13)	6.00(12)	4.60(50)
al pool	2.70(10)	1.00(7)	2.40(10)	2.12(8)	2.14(35)
	3.55(22)	2.50(20)	3.82(23)	4.45(20)	3.59(85)

e surf and tidal pool collections differ significantly th respect to number of species per collection when l over both years and all seasons (Table 7). The f the analysis of variance also indicate a significant seasonal effect. Student-Newman-Keuls' test was ed to determine which of the overall seasonal means nificantly different (Sokal and Rohlf 1969). The indicate that only winter and summer differ nificantly in number of species per collection; all other sons were nonsignificant.

esults of the analysis of variance for the number specimens per collection are presented in Table 8, indicating that neither the year effect nor the main effect of s significant. On the other hand, both the main

le 8.—Analysis of variance for X = log (number of specimens of es per collection + 1). (Highly significant, $P< 0.01$; ns not sig- cant, $P > 0.05$.)**

Source	SS	df	MS	*F*
ks (years)	1.4906	1	1.4906	3.565 ns
	3.5807	1	3.5807	8.563 **
	0.6739	3	0.2246	0.537 ns
ation by season	6.4340	3	2.1447	5.129 **
er	31.7783	76	0.4181	
	43.9575	84		

ect of location and the location-by-season interaction highly significant. The back-transformed location- n means (means expressed in the original units urement) for both years combined are (number of ections in parentheses):

	Fall	*Winter*	*Spring*	*Summer*
	20.66(12)	56.00(13)	18.88(13)	38.69(12)
al pool	23.02(10)	2.50(7)	18.19(10)	8.84(8)

of the highly significant interaction of location d season, an examination of this interaction was undertaken to determine location differences within season; of t-tests for surf versus tidal pool are: fall 0.16, 0.05; winter 4.00, $P< 0.01$; spring 0.06, $P> 0.05$; mmer 2.05, $P< 0.05$. These single degree-of-freedom sons are not independent, but are warranted the interaction is highly significant. They in- cate that there is a highly significant difference tween the average number of specimens per collection urf and the average number of specimens per n in the tidal pool for those collections made in nter, a significant difference for summer, and a non- nificant difference for both fall and spring.

9 gives the results of the analysis of variance for eight per collection which indicate a highly

Table 9.—Analysis of variance for X = log (total weight of fishes per collection + 1). (*Significant, $P< 0.05$; **highly significant, $P< 0.01$; ns not significant, $P > 0.05$.)

Source	SS	df	MS	*F*
Blocks (years)	4.4421	1	4.4421	8.288 **
Location	12.5504	1	12.5504	23.416 **
Season	1.2729	3	0.4243	0.792 ns
Location by season	5.8823	3	1.9608	3.658 *
Error	40.7355	76	0.5360	
Total	64.8832	84		

significant difference between years for the total weight of fishes per collection. This is due in part to the capture during the first year of 20 *Mugil cephalus* with a total weight in excess of 1.5 kg and a single specimen of *Pogonias cromis* which weighed more than 1.2 kg. A variation in seining technique (see section on Materials and Methods) may have contributed to the capture of these large specimens because two short tows may have been more effective in collecting large individuals than a single long tow. The main effect of season is not significant. Both the main effect of location and the location-by-season interaction were found to be significant. The back-transformed location-by-season means (in grams) for both years combined are (number of collections in parentheses):

	Fall	*Winter*	*Spring*	*Summer*
Surf	75.87(12)	184.60(13)	101.24(13)	146.66(12)
Tidal pool	59.56(10)	5.84(7)	22.37(10)	11.34(8)

Single degree-of-freedom comparisons of location differences within season show that the surf does not differ significantly from the tidal pool for those collections made in the fall, but surf and tidal pool collections differ significantly for each of the other seasons with respect to the average total weight of fishes per collection (results of t-tests are: fall 0.33, $P> 0.05$; winter 4.18, $P< 0.01$; spring 2.08, $P< 0.05$; summer 3.23, $P< 0.01$).

Ranking of Species

The more common species (represented by at least 100 specimens) were *Arenaeus cribrarius*, *Anchoa mitchilli*, *Fundulus majalis*, *Menidia menidia*, *Trachinotus carolinus*, *Menticirrhus littoralis*, and *Mugil curema*. The six species of fishes accounted for 94% of the specimens of fishes collected (4,767 of 5,095) and 72% of the ichthyomass (12,406 of 17,318 g). One species, *Areneaus cribrarius*, made up 82% of the swimming invertebrate specimens (422 of 512) and 75% of the mass of swimming invertebrates (3,218 of 4,300 g). These species were ranked to determine their relative importance. Of the seven most important species, one (*F. majalis*) was not a significant part of the catch in the surf, and three (*A. cribrarius*, *A. mitchilli*, and *M. littoralis*) were of little consequence in the tidal pool.

We developed a seasonal index to allow ordering of species by seasonal occurrence. It is defined as:

$$\text{Seasonal index} = 1 + \log N \cdot \sum_{i=1}^{4} \frac{D_i \, C_i}{M_i}$$

where N = total number collected,
D_i = days collected in the i^{th} season,
C_i = months collected in the i^{th} season,
M_i = number of months in the i^{th} season.

Although arbitrary in its design, this index does contain the elements implicit in the meaning of seasonality, and the lower the seasonal index for a species the more seasonal is its occurrence.

Species were ranked by number of specimens, frequency of appearance (number of days collected), weight, and seasonality (seasonal index). For each of these categories the values were ordered and the highest value was given a rank of one, the second highest a rank of two, etc. In determining rank of importance, the individual ranks for each species were weighted equally and summed. The ordered sums were then ranked as "importance" (Table 10). In the surf and tidal pool combined, *M. menidia* was the most important species, followed by *A. cribrarius*, *T. carolinus*, *M. littoralis* and *M. curema*, *A. mitchilli*, and *F. majalis*.

Relationships Between Environmental Variables and Occurrence

A major objective of this study was to determine the relationships of the occurrence of the fauna to certain environmental variables using multiple regression techniques. The collections made in the surf were chosen for more detailed analyses. Effects of environmental variables on collections made in the tidal pool were not examined because conditions at the time of pool formation were not known.

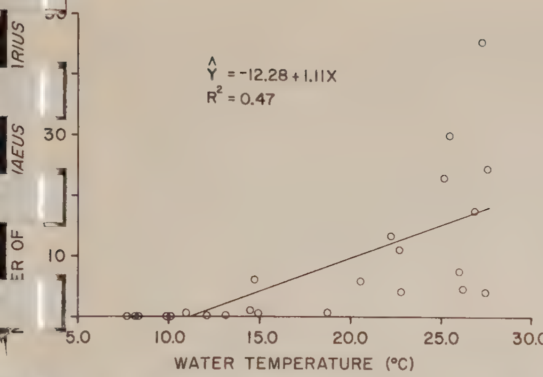
Five of the most important species in the surf were selected to determine which environmental variables are important to their occurrence. The species chosen were *Arenaeus cribrarius*, *Anchoa mitchilli*, *Menidia me*
Trachinotus carolinus, and *Menticirrhus littoralis*.
curema was not chosen because it was present in
the 51 surf collections. Five variables (duration
water temperature, salinity, height of sea, and vis
of Secchi disc) were chosen for analysis. W
stepwise regression techniques to choose the
equation (Draper and Smith 1966) for each of
selected species in the following manner:

1. Occurrence was plotted versus enviro
variables and the data were linearized,
necessary;
2. Simple correlation coefficients between oc
and the environmental variables were com
3. Using the multiple regression model, $Y = \beta +$
$\beta_2 Z_2 + \ldots + \beta_p Z_p + \epsilon$, where Y = occurren
Z_i is some function of one of the five sele
vironmental variables, $X_1, X_2, \ldots, X_5$, a
regression was preformed to identify
parameters which account for the attr
variations in the model; and
4. For each final regression equation residu
analyzed.

Variation within months, which we did not
significant, was removed by using monthly avera
all data. Only temperature showed a marked
effect. The mean number of specimens per collec
plotted for each species versus mean water temp
(by months). The pattern for *A. cribrarius* (Fig.
typical of all species except *M. menidia* (Fig. 2).
menidia was much more abundant at the lowe
temperatures, while the converse was true for th
species. Figures 1 and 2 indicate the possible ut
the square of water temperature as an additi
dependent variable because the relationships a
be curvilinear functions.

Table 10.—Rank of the seven most important species collected during Folly Beach survey (Oct. 1969-Oct. 1971). Ranks are i
parentheses. Appearance equals number of days collected (because of this the number of days collected in surf and tidal poo
combined does not equal number of days collected in surf plus number of days collected in tidal pool).

	Species	Number	Appearance	Weight (g)	Seasonal index	Sum of ranks	Importance
Surf:	*Menidia menidia*	1,485(1)	36(1)	4,025(1)	109.7(1)	4	1
	Arenaeus cribrarius	417(2)	32(3)	3,209(2)	76.6(2)	9	2
	Menticirrhus littoralis	291(4)	34(2)	831(5)	72.9(3)	14	3
	Anchoa mitchilli	362(3)	29(4.5)	350(6)	63.7(4)	17.5	4
	Trachinotus carolinus	266(5)	29(4.5)	1,018(4)	62.0(5)	18.5	5
	Mugil curema	121(6)	9(6)	2,591(3)	11.7(6)	21	6
Tidal pool:	*Menidia menidia*	630(2)	18(1)	2,201(1)	31.2(1)	5	1
	Trachinotus carolinus	710(1)	13(3)	501(3)	21.8(2)	9	2
	Fundulus majalis	341(4)	15(2)	734(2)	20.9(3)	11	3
	Mugil curema	545(3)	7(4)	118(4)	8.5(4)	15	4
Surf and tidal pool combined:	*Menidia menidia*	2,115(1)	40(1)	6,226(1)	126.9(1)	4	1
	Arenaeus cribrarius	422(4)	35(2)	3,218(2)	76.7(2)	10	2
	Trachinotus carolinus	976(2)	29(5)	1,519(4)	76.2(3)	14	3
	Menticirrhus littoralis	294(7)	34(3)	843(5)	73.0(4)	19	4.5
	Mugil curema	666(3)	14(7)	2,709(3)	29.2(6)	19	4.5
	Anchoa mitchilli	372(5)	30(4)	365(7)	66.5(5)	21	6
	Fundulus majalis	344(6)	16(6)	744(6)	23.0(7)	25	7



—Mean number of *Arenaeus cribrarius* per collection ver-
an water temperature for surf collections (by months).

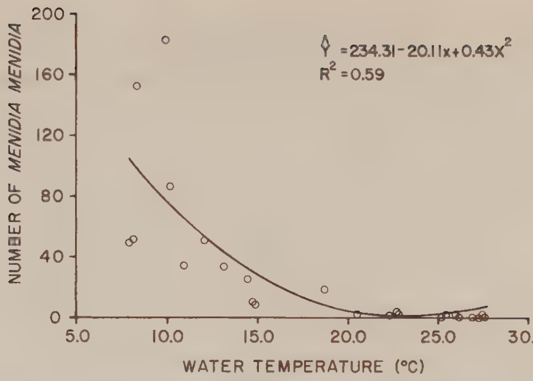


Figure 2.—Mean number of *Menidia menidia* per collection versus mean water temperature for surf collections (by months).

imple correlation coefficients of monthly averages of
mental variables and monthly average number of
ens per collection in the surf are given in Table 11.
ter temperature and its square correlated significant-
with number of specimens for all species. Height of sea
nificantly correlated with occurrence for *A.*
i and *M. littoralis.* A significant negative correla-
existed between salinity and number of specimens
menidia. No other correlations were significant.
vise regression was then undertaken for each
ies. The list of variables and notation used is con-
ned in Table 12. In addition to the stepwise procedure,
pendent variables were forced to enter the equa-
rward selection) to assess the percentage reduc-
on of the sum of squares of deviations of Y from its
ean attributed to regression.

amination of residuals ($e_i = Y_i - \hat{Y}_i$) was con-
using the methods of Draper and Smith (1966). In
nducting the regression analyses, assumptions were
ade about e_i: errors were independent, had zero mean
onstant variance, and followed a normal distribu-
esiduals were examined to see if these assump-
ons were violated and to suggest possible transfor-
s of the variables (e.g., squares and cross products
independent variables). Residuals for the final
uations selected for each species were plotted overall,
time sequence, against the fitted values $\hat{Y}_i$, and
the independent variables X_{ji}, for $j = 1, 2, \ldots,$
assumptions apparently were not violated, with
e exception. There appeared to be a time sequence
fect for some species when the residuals were ordered by month, i.e., long runs of positive residuals followed by runs of negative residuals. A one-sample runs test was used to examine this time sequence effect. Results were not significant. It was concluded that our final equations did not violate the assumptions and no other transformations seemed relevant.

The summary statistics for the forward selection of six independent variables are given in Tables 13 through 17 along with the final equation selected by the stepwise procedure.

Water temperature (or the square of water temperature) was more highly correlated with occurrence than any of the other independent variables (Table 11). The stepwise procedure was modified to enter water temperature before its square. This modification had little effect on the results because the correlation between water temperature and its square was high ($r = 0.992$).

Table 12.—List of variables and notation for stepwise multiple regression.

Response variables Monthly average number of specimens per collection in the surf		Independent variables Monthly average in the surf	
Y_1	*Arenaeus cribrarius*	X_1	duration of effort (min)
Y_2	*Anchoa mitchilli*	X_2	water temperature (°C)
Y_3	*Menidia menidia*	X_3	salinity (°/₀₀)
Y_4	*Trachinotus carolinus*	X_4	height of sea (m)
Y_5	*Menticirrhus littoralis*	X_5	visibility of Secchi disc (m)
		X_6	square of water temperature

Table 11.—Simple correlation coefficients of monthly averages (N = 24) of environmental variables and monthly average number of specimens per collection in the surf for five selected species. (*Significant correlation, $P < 0.05$; **highly significant correlation, $P < 0.01$.)

Species	Duration (min)	Water temperature (°C)	Salinity (‰)	Height of sea (m)	Visibility of Secchi disc (m)	Square of water temperature (°C)²
Arenaeus cribrarius	0.080	0.683**	0.275	0.296	0.082	0.706**
Anchoa mitchilli	−0.104	0.405*	0.242	0.402*	−0.329	0.405*
Menidia menidia	−0.232	−0.711**	−0.495*	−0.167	0.056	−0.667**
Trachinotus carolinus	0.237	0.657**	0.370	0.002	0.149	0.674**
Menticirrhus littoralis	−0.219	0.497*	0.208	0.464*	−0.113	0.506*

Table 13.—Summary statistics for forward selection of six independent variables for *Arenaeus cribrarius* (Y_1 = response variable; R = correlation coefficient). (Highly significant, $P<0.01$; ns not significant, $P>0.05$.)**

Step number	Variable entered	Multiple R	R^2	Increase in R^2	Partial F-test
1	X_2	0.6830	0.4665	0.4665	19.2372**
2	X_6	0.7199	0.5182	0.0517	2.2557 ns
3	X_1	0.7273	0.5290	0.0107	0.4558 ns
4	X_5	0.7301	0.5330	0.0040	0.1627 ns
5	X_3	0.7309	0.5343	0.0013	0.0494 ns
6	X_4	0.7310	0.5343	0.0000	0.0011 ns

Step 1 prediction equation: $\hat{Y}_1 = -12.2821 + 1.1120\,X_2$

Table 14.—Summary statistics for forward selection of six independent variables for *Anchoa mitchilli* (Y_2 = response variable; R = correlation coefficient). (*Significant, $P < 0.05$; ns not significant, $P > 0.05$.)

Step number	Variable entered	Multiple R	R^2	Increase in R^2	Partial F-test
1	X_2	0.4046	0.1637	0.1637	4.3065*
2	X_5	0.5740	0.3295	0.1658	5.1926*
3	X_4	0.6063	0.3675	0.0380	1.2030 ns
4	X_3	0.6249	0.3905	0.0230	0.7159 ns
5	X_1	0.6558	0.4301	0.0396	1.2519 ns
6	X_6	0.6596	0.4350	0.0049	0.1471 ns

Step 2 prediction equation: $\hat{Y}_2 = 7.3141 + 0.7816\,X_2 - 34.4694\,X_5$

Table 15.—Summary statistics for forward selection of six independent variables for *Menidia menidia* (Y_3 = response variable; R = correlation coefficient). (*Significant, $P < 0.05$; **highly significant, $P < 0.01$; ns not significant, $P > 0.05$.)

Step number	Variable entered	Multiple R	R^2	Increase in R^2	Partial F-test
1	X_2	0.7105	0.5048	0.5048	22.4299**
2	X_6	0.7694	0.5920	0.0872	4.4892*
3	X_3	0.8409	0.7070	0.1150	7.8503*
4	X_5	0.8553	0.7316	0.0246	1.7395 ns
5	X_4	0.8619	0.7430	0.0113	0.7943 ns
6	X_1	0.8624	0.7437	0.0007	0.0494 ns

Step 3 prediction equation:

$\hat{Y}_3 = 566.8066 - 23.2452\,X_2 - 10.3017\,X_3 + 0.5368\,X_6$

The final regression equation for *M. menidia* contained water temperature, the square of water temperature, and salinity as predictor variables. Water temperature accounted for 50% of the variation in Y due to regression ($R^2 = 0.50$). The addition of salinity and the square of water temperature as independent variables increased R^2 to 71%. Forcing the addition of the remaining variables increased R^2 to only 74%. For all other species, except *A. mitchilli*, water temperature was the only variable selected. The final regression equation selected for *A. mitchilli* contained water temperature and visibility of Secchi disc as independent variables. The best fit (R^2) was obtained for *M. menidia* ($R^2 = 0.71$), followed by *A. cribrarius* ($R^2 = 0.47$), *T. carolinus* ($R^2 = 0.43$), *A. mitchilli* ($R^2 = 0.33$), and *M. littoralis* ($R^2 = 0.25$).

Table 16.—Summary statistics for forward selection independent variables for *Trachinotus carolinus* (Y_4 = variable; R = correlation coefficient). (Highly significant, ns not significant, $P > 0.05$.)**

Step number	Variable entered	Multiple R	R^2	Increase in R^2	Pa F
1	X_2	0.6569	0.4315	0.4315	16.70
2	X_4	0.7115	0.5063	0.0747	3.17
3	X_6	0.7348	0.5399	0.0337	1.46
4	X_3	0.7392	0.5464	0.0064	0.26
5	X_5	0.7414	0.5497	0.0034	0.13
6	X_1	0.7415	0.5498	0.0001	0.00

Step 1 prediction equation: $\hat{Y}_4 = -7.6441 + 0.7025\,X_2$

Table 17.—Summary statistics for forward selection independent variables for *Menticirrhus littoralis* (Y_5 = variable; R = correlation coefficient). (*Significant, $P<$ 0.0 significant, $P > 0.05$.)

Step number	Variable entered	Multiple R	R^2	Increase in R^2	Pa F
1	X_2	0.4969	0.2469	0.2469	7.214
2	X_1	0.5909	0.3492	0.1022	3.299
3	X_4	0.6372	0.4060	0.0568	1.912
4	X_3	0.6697	0.4485	0.0426	1.466
5	X_6	0.6835	0.4672	0.0187	0.631
6	X_5	0.6993	0.4890	0.0218	0.724

Step 1 prediction equation: $\hat{Y}_5 = -4.6371 + 0.5718\,X_2$

Ordering the regression equations on the basis c the five selected species resulted in the same ran the "importance" for surf and tidal pool co (Table 10) with the exception of a reversal o between *A. mitchilli* and *M. littoralis.*

Livingston et al. (1976) performed similar reg analyses for species collected in a study of Apala Bay, Fla. The only species analyzed in both thei and ours was *Anchoa mitchilli.* Of the indep variables examined for this species by Livingsto only chlorophyll a and visibility of Secchi dis significant contributors to R^2 (with chlorophyll more important). Their R^2 for *A. mitchilli* wa Clarity of water (by visibility of Secchi disc), the important factor in determining the presence *mitchilli.*

Annotated List of Selected Species

The seven species included in the section on and several others are considered below in some Temperature and salinity ranges for these spe presented in Table 3; and numbers and size ra month are given in Table 4.

Arenaeus cribrarius (Lamarck) (Crustacea, De Portunidae). This species was collected in summer, and fall of both years and in wint specimen in March) of the second year. In 35 co (32 from the surf and 3 from the tidal po specimens of 7 to 141 mm CW (417, 7-141 mm C the surf and 5, 17-59 mm CW, from the tidal po

brarius weighing 3,218 g (3,209 from the surf and 9
m the tidal pool) were captured. The relationship of
umber per collection and mean station water
ature (in the surf by months) is shown in Figure 1;
d carapace width frequency data for tidal pool and surf
mbined, in Table 18. Ovigerous females were collected
as mid-June and recently spawned ones as late
September. These data, along with the presence
small individuals (20 mm CW or smaller) from May
October, show that *A. cribrarius* has a prolonged
ng period.

Alosa aestivalis (Mitchill) (Clupeidae). In five collec-
ons (all from the surf), 22 specimens of 42 to 62 mm SL
were collected. As Berry (1964) pointed out, it is
t to identify small specimens of *Alosa* using any
escription or key. The characters which appear to be
ost useful in identifying the species of the Atlantic
e (*A. sapidissima, A. mediocris, A. aestivalis*, and
doharengus) are the number of gill rakers on the
wer limb of the anterior gill arch and total number of
tebrae (Hildebrand 1963; Berry 1964). Our specimens
wer-limb gill raker counts of 36 to 41 ($\bar{x}$ = 37.82)
tebral counts of 49 to 51 ($\bar{x}$ = 50.00). The high gill
ker counts eliminate *Alosa mediocris* and the low
al counts remove *A. sapidissima* from further con-
ion. According to Hildebrand (1963), *Alosa*
estivalis has 49 to 53 vertebrae, whereas *A.*
seudoharengus has 46 to 50. Both *A. aestivalis* and *A.*
harengus show an increase in number of gill rakers
owth until adult sizes are reached (Hildebrand
963). Hildebrand (1963) gave lower-limb gill raker
ounts as follows: *A. aestivalis*, specimens of 30 to 49 mm
to 36, specimens of 50 to 69 mm SL—30 to 39; *A.*
harengus, specimens of 30 to 49 mm SL—25 to 33,
ecimens of 50 to 69 mm SL—32 to 36. Our material, then, is more similar to *Alosa aestivalis* (Mitchill) than to *Alosa pseudoharengus* (Wilson). We have, therefore, considered our specimens of *Alosa* as *A. aestivalis*.

Dorosoma petenense (Günther) (Clupeidae). One specimen of 73 mm SL of *Dorosoma petenense* was collected in the surf on 24 August 1970. Although *D. petenense* has been introduced into freshwater reservoirs in the southeast, we have found no record published prior to 1974 of its occurring in the estuarine or marine waters of South Carolina. According to Miller (1963), it has been collected from the Gulf Coast of the United States and southward to northern Guatemala and British Honduras. Donald C. Scott (University of Georgia) stated (pers. commun.) that in addition to its having been introduced into reservoirs in Georgia, there was a native stock of *D. petenense* present at least as far back as 1955 in the Satilla River which drains into the Atlantic, and, at present, it is widespread along the coast having been taken in beach collections at Sapelo and near Brunswick and Savannah. Miller and Jorgenson (1969) reported this species from collections made in the surf at St. Simons Island, Ga. In addition to the specimen collected at Folly Beach, one was collected on 9 February 1970 near Dewees Inlet at the northeast end of the Isle of Palms, in Charleston County (lat. 32°48.8′N, long. 79°43.0′W). Shealy et al. (1974) collected numerous specimens in 1973-74 during a survey of South Carolina's estuaries.

Anchoa mitchilli (Valenciennes) (Engraulidae). This species was collected in all seasons of both years, least commonly in winter. In 30 collections (29 from the surf and 1 from the tidal pool), 372 specimens of 20 to 60 mm SL (362, 20-60 mm SL, from the surf and 10, 47-58 mm SL, from the tidal pool) of *A. mitchilli* weighing 365 g (350 from the surf and 15 from the tidal pool) were collected.

18.—Carapace width frequencies (%) by month for *Arenaeus cribrarius* collected in tidal pool and surf combined during the Folly Beach survey. One specimen of 140.8 mm CW, collected in August 1971, is denoted by an asterisk.

	Carapace width (mm)														
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	121-130	131-140	*N*
969															
Oct.		13.0		34.8	4.3	8.7	17.4	4.3	13.0		4.3				23
					50.0			50.0							2
Apr.				100.0											1
May		12.5	25.0	12.5	12.5	25.0	12.5								8
		1.7	15.3	42.4	23.7	3.4	11.9	1.7							59
		25.0	12.5	25.0	12.5	12.5		12.5							8
Aug		4.4	86.8	8.8											91
Sept.		11.1	33.3	44.4			11.1								9
Oct.		27.3	27.3	18.2	9.1	9.1		9.1							11
			100.0												1
Mar.			100.0												1
Apr.			41.7	33.3	8.3		8.3			8.3					12
			20.0	6.7	13.3		60.0								15
			46.7	20.0			6.7			20.0	6.7				15
		20.4	51.0	10.2	10.2	2.0			4.1					2.0	49
Aug.		60.0	20.0	5.7	2.9	2.9	2.9			2.9				2.9*	35
Sept.	4.3	6.5	50.0	23.9	2.2		2.2	2.2	2.2			2.2	2.2	2.2	46
		3.2		12.9	12.9	35.5	12.9	12.9	6.5	3.2					31
															417

Fundulus majalis (Walbaum) (Cyprinodontidae). Although this species was collected in all seasons of both years except the spring of the second year, 71% of the specimens were obtained during the summer. In 18 collections (3 from the surf and 15 from the tidal pool), 344 specimens of 26 to 84 mm SL (3, 38-67 mm SL, from the surf, and 341, 26-84 mm SL, from the tidal pool) of *F. majalis* weighing 744 g (10 from the surf and 734 from the tidal pool) were collected.

Menidia spp. (Atherinidae). Rubinoff and Shaw (1960) separated *Menidia beryllina* (Cope) collected in Massachusetts from *M. menidia* (Linnaeus) collected in Massachusetts and New York mainly on the basis of number of soft rays in the anal fin. Their 251 specimens of *M. beryllina* had a range of 14 to 19, usually 15 to 17, anal soft rays ($\bar{x}$ = 15.6), whereas their 134 specimens of *M. menidia* had a range of 20 to 29, usually 22 to 25 ($\bar{x}$ = 23.5). In Rubinoff and Shaw's collections only one specimen had 19 anal soft rays and only one had 20. They assigned these specimens to species on the basis of size and total number of lateral scales.

Robbins (1969) examined *M. beryllina* collected from Massachusetts to Vera Cruz, Mexico, and *M. menidia* from Prince Edward Island to northeastern Florida. In 1,952 specimens of *M. beryllina*, he found a range of 12 to 21, usually 15 to 18, anal soft rays ($\bar{x}$ = 16.37), and in 1,504 specimens of *M. menidia* a range of 19 to 29, usually 21 to 26 ($\bar{x}$ = 23.60).

The distribution of counts of anal soft rays for 1,658 of our 2,141 specimens of *Menidia* is:

	N	%
16	1	0.1
17	0	0.0
18	3	0.2
19	16	1.0
20	94	5.7
21	292	17.6
22	511	30.8
23	415	25.0
24	223	13.4
25	85	5.1
26	16	1.0
27	1	0.1
28	1	0.1

Because the distribution appears almost normal there may be only one species of this genus represented in our collections. A contrary interpretation, and the one that we prefer, is that both *Menidia beryllina* and *M. menidia* are present, but due to overlap in ranges of counts of anal soft rays there is no clear line of demarcation between the species using this character. On a number of specimens, representing the entire range of counts of anal fin rays recorded, we counted total vertebrae and lateral scales. These counts were of little help in separating the two species. Weighing the preceding, we arbitrarily considered specimens of *Menidia* with 19 or fewer anal soft rays as *M. beryllina* and those with 20 or more as *M. menidia*.

In 14 collections (10 from the surf and 4 from the tidal pool), 26 specimens of 46 to 75 mm SL (22, 52-75 mm SL,
from the surf and 4, 46-65 mm SL, from the tidal p
M. beryllina weighing 53 g (44 from the surf and
the tidal pool) were obtained. This species was co
in the autumn and winter of both years and in the
of the first year.

In 54 collections (36 from the surf and 18 from th
pool), 2,115 specimens of 21 to 89 mm SL (1,485
mm SL, from the surf and 630, 31-86 mm SL, fr
tidal pool) of *M. menidia* weighing 6,226 g (4,025
the surf and 2,201 from the tidal pool) were ob
This species was collected in all seasons of both
However, 53% of the specimens were seined in wint
less than 0.5% in summer. The relationship of
number per collection and mean station
temperature (in the surf by months) is shown in
2. Small individuals of *M. menidia* utilize habitats
than those of the surf zone. Only about 0.4%
specimens collected were 50 mm SL or smaller
19). We do not believe that the virtual absence
menidia less than 50 mm SL is an artifact of the
ting method because we collected numbers of sm
dividuals of similarly shaped species. Ripe indiv
were noted from late March to early June. Cupka
found sexually mature specimens from mid-
through early June.

Trachinotus carolinus (Linnaeus) (Carangidae)
species was collected in both years in all seasons
winter, but 68% of the specimens were seined in the
of the first year. Most of those caught in that
were less than 30 mm SL and from the tidal pool
20). Almost 61% of the total number were obtaine
the tidal pool on two successive collecting days i
1970. A prolonged spawning period is indicated f
species because small specimens (22 mm SL or sm
were caught from mid-April through late O
(specimens 14 mm SL or smaller in April, May,
September, and October). This is similar to the fi
of several other authors (Fields 1962; Finucane
Bellinger and Avault 1970; Cupka 1972). In 42 colle
(29 from the surf and 13 from the tidal pool
specimens of 12 to 93 mm SL (266, 12-93 mm SL
the surf and 710, 12-66 mm SL, from the tidal pool
carolinus weighing 1,519 g (1,018 from the surf a
from the tidal pool) were obtained.

Menticirrhus littoralis (Holbrook) (Sciaen
Although this species was collected in all seasons
years, 62% of the specimens were obtained in su
but only about 3% in winter. In 36 collections (3
the surf and 2 from the tidal pool), 294 specimens
149 mm SL (291, 19-149 mm SL, from the surf and
76 mm SL, from the tidal pool), of *M. littoralis* we
843 g (831 from the surf and 12 from the tidal pool
collected. Hildebrand and Cable (1934) suggeste
spawning starts near Cape Lookout, N.C., no late
1 May and continues into August. The capture
dividuals measuring less than 30 mm SL from
through November during our survey indicates a
situation off South Carolina with spawning proba
tending into September (Table 21). Tagatz and

Table 19.—Standard length frequencies (%) by month for *Menidia menidia* collected in the tidal pool (T) and surf (S) during the Folly Beach survey.

	Standard length (mm)												
	21-30		41-50		51-60		61-70		71-80		81-90		
Month	T	S	T	S	T	S	T	S	T	S	T	S	*N*
1969													
Oct.			1.1		50.0	1.1	37.5	6.8	3.4				88
Nov.					6.3	14.1	15.6	53.1		10.9			64
Dec.				1.3	3.1	38.6	14.9	31.6	5.3	3.9	0.9	0.4	228
1970													
Jan.				1.0	1.0	36.9	1.0	51.5	1.9	5.8	1.0		103
Feb.						20.8		67.3		11.9			101
Mar.						3.8	1.3	46.5	1.9	44.6		1.9	157
Apr.						2.8		36.1		61.1			36
May					3.1		42.0	0.8	51.1	0.4	2.7		262
June							43.8	12.5	31.2	6.3	6.3		16
July								50.0		25.0		25.0	4
Aug.	100.0												1
Oct.								100.0					2
Nov.					11.4	1.6	51.6	3.8	26.6	3.3	1.6		184
Dec.						35.3		55.9		7.4		1.5	67
1971													
Jan.				0.3		49.1	1.9	40.9	2.5	5.0	0.3		320
Feb.						10.6		57.5		30.5		1.4	367
Mar.						23.2		60.9		15.9			69
Apr.						4.5	4.5	36.4	9.1	40.9		4.5	22
May							20.0	26.7	33.3	20.0			15
June		25.0						25.0		50.0			4
Sept.					100.0								1
Oct.					50.0		50.0						2
													2,113

also reported specimens of similar size taken from une through November near Cape Lookout, N.C.

M il cephalus Linnaeus (Mugilidae). Although this was collected in fall (1969), winter (1970 and 971), spring (1971), and summer (1970), most specimens ere collected in winter (27%) and spring (64%). In 11 collections (8 from the surf and 3 from the tidal pool), 73 specimens of 17 to 328 mm SL (26, 25-229 mm SL from the surf and 47, 17-328 mm SL from the tidal pool) of *M. cephalus* weighing 2,426 g (1,786 from the surf and 640 from the tidal pool) were obtained. Even though *Mugil cephalus* outranks four of the seven most impor-

0.—Standard length frequencies (%) by month for *Trachinotus carolinus* collected in the tidal pool (T) and surf (S) during the Folly Beach survey.

	Standard length (mm)															
	11-20		21-30		31-40		41-50		51-60		61-70		71-80	81-90	91-100	
lonth	T	S	T	S	T	S	T	S	T	S	T	S	S	S	S	*N*
		1.3	30.7	8.0	17.3	5.3	6.7	6.7	9.3	5.3	5.3	2.7	1.3			75
Nov.						50.0				50.0						2
970																
	5.6	5.6	55.5	22.1		5.6		5.6								18
	37.3	0.3	36.5	1.7	13.0	1.2	3.1	2.0	1.7	0.9		2.0	0.2			646
			3.0	21.2		21.2	3.0	36.4	3.0	9.1				3.0		33
Aug.		5.9	29.4	5.9	11.8			8.8		14.7		8.8	11.8	2.9		34
Sept.	37.5	12.5	25.0			12.5				12.5						8
	25.0	5.6	33.3	11.1		13.9		5.6		2.8		2.8				36
					7.1		28.6	7.1		42.9		14.3				14
971																
Apr.		100.0														1
		12.5		62.5		25.0										8
		4.1		2.0		8.2		18.4		38.8		22.4	6.1			49
				26.9		23.1		38.5		11.5						26
Aug.				27.3				27.3		9.1		18.2	9.1		9.1	11
Sept.	20.0	20.0	20.0							20.0		20.0				5
			44.4	11.1			11.1			22.2		11.1				9
																975

Table 21.—Standard length frequencies (%) by month for *Menticirrhus littoralis* collected in the surf during the Folly Beach surve

Month	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	141-150
1969												
Oct.		16.7	27.8	22.2	16.7	5.6	11.1					
Nov.				50.0	50.0							
1970												
Jan.					100.0							
Apr.								100.0				
June		12.5	50.0		25.0		12.5					
July	50.0			50.0								
Aug.			21.1	21.1	36.8	10.5	10.5					
Sept.		25.0	8.3	33.3	8.3		8.3		16.7			
Oct.			11.1	33.3	33.3	22.2						
Nov.		37.0	33.3	18.5	7.4					3.7		
Dec.						60.0	20.0			20.0		
1971												
Feb.								25.0	25.0	25.0		25.0
Mar.					20.0	60.0	20.0					
Apr.				23.5	11.8	23.5	5.9	17.6	11.8		5.9	
May								100.0				
June			25.0	50.0						25.0		
July	3.6	23.6	30.9	18.2	5.5	10.9	3.6	1.8				1.8
Aug.		17.1	22.9	42.9	11.4	2.9				2.9		
Sept.		11.9	23.7	30.5	20.3	8.5	5.1					
Oct.		14.3	71.4	14.3								

tant species in weight (Table 10), it was not considered with that group because it was represented by a relatively small number of specimens.

Mugil curema Valenciennes (Mugilidae). This species was collected in both years in all seasons except winter. Seventy-nine percent of the specimens (all less than 30 mm SL) were caught in the first spring, whereas 15% (most between 86 and 130 mm SL) were caught during the first summer (Table 22). In 16 collections (9 from the surf and 7 from the tidal pool), 666 specimens of 19 to 130 mm SL (121, 22-130 mm SL, from the surf and 545, 19-73 mm SL, from the tidal pool) of *M. curema* weighing 2,709 g (2,591 from the surf and 118 from the tidal were obtained.

Paralichthys squamilentus Jordan and G (Bothidae). This species was collected in spring o years (89% of total), summer of the second year, a October 1971. In 10 collections (9 from the surf from the tidal pool), 19 specimens of 34 to 115 m (17, 34-115 mm SL, from the surf and 2, 44-58 mn from the tidal pool) of *P. squamilentus* weighing (76 from the surf and 6 from the tidal pool) collected. Bearden (1971) noted that few reco juvenile *Paralichthys squamilentus* have appeared i

Table 22.—Standard length frequencies (%) by month for *Mugil curema* collected in the tidal pool (T) and surf (S) during the Folly Beach

	11-20	21-30		61-70	71-80		81-90	91-100	101-110	111-120	121-130
Month	T	T	S	S	T	S	S	S	S	S	S
1969											
Oct.	100.0										
1970											
May	23.5	76.5									
June	0.8	99.2									
July	5.0	75.0	10.0	10.0							
Aug.								100.0			
Sept.							2.7	36.0	41.3	18.7	1.3
Oct.						8.3	25.0	45.8	12.5	8.3	
1971											
Apr.	100.0										
May		100.0									
July			100.0								
Aug.							66.7	33.3			
Oct.					100.0						

iterature. He reported 60 juvenile specimens (25-88 mm L) of *P. squamilentus* caught in shallow water (0.3-1.3 nine open ocean beach stations in South Carolina y and June 1969. Cupka (1972) collected two pecimens (56-97 mm SL, one in May 1971 and one in t 1971) from the surf zone in South Carolina. en (1971) offered two possible explanations for the ppearance of *P. squamilentus* off the beaches of South Carolina in 1969: 1) 1969 may have been a year when ing was unusually successful, or 2) the juveniles of *uamilentus* may have been misidentified or verlooked previously. Because we collected juveniles of *P. squamilentus* in the two succeeding years, the rance of juveniles of this species in 1969 does not unusual. A more plausible interpretation of the ata is that the apparent absence of juveniles of *P. quamilentus* in the waters of South Carolina before 1969 result for the most part of inadequate collecting.

oeroides spengleri (Bloch) (Tetraodontidae). One pecimen, 16 mm SL, of *S. spengleri* was collected from rf on 10 October 1971. Shipp and Yerger (1969) that *S. spengleri* is "Widespread in the western tlantic and adjacent waters, in shallow water." Our pecimen was identified by Robert L. Shipp (University th Alabama) who wrote one of us (24 March 1972) *. spengleri* wanders as far north as Massachusetts nd is fairly common at Bermuda, but to his knowledge his is the first record from South Carolina.

omycterus ? (Diodontidae). Two specimens, 12 to SL, of a diodontid were collected from the surf on 6 July 1971 after the passage of a tropical storm. These ish resemble *Lyosphaera globosa* as shown in pl. 267 of and Evermann (1900). According to Fraser-er (1943), *Lyosphaera* is a junior synonym of *Chilomycterus*.

ionships of Lengths and Lengths o Weight

relationships of carapace length to carapace width hese measurements to weight are presented in Table 23 for the decapod crustacean *Arenaeus cribrarius*. The relationships of lengths and lengths to weight are nted in Tables 24 through 31 for the following *Anchoa mitchilli*, *Fundulus majalis*, *Menidia menidia*, *Trachinotus carolinus*, *Trachinotus falcatus*, *cirrhus littoralis*, *Mugil cephalus*, and *Mugil a*. All lengths of fishes were measured from the tip of the snout: standard length, to the structural base of the caudal fin; fork length, to the bifurcation of the caudal fin; and total length, to the distal tip of the longest caudal ray.

Equations of length to length relationships were derived by the method of least squares and are of the form $Y = a + bX$ (where Y = dependent variable or predicted length, a = Y intercept, b = coefficient of regression, and X = independent variable or observed length). Equations of length to weight were also obtained by the method of least squares after a $\log_{10}$ -$\log_{10}$ transformation of the original data, and are of the form $Y = a + bX$ (where Y = log weight and X = log length). This transformation was used to convert the analyses from curvilinear to simple linear regression. For each regression analysis we have included the sum of squares and cross products of deviations for ease of comparison with other data. In Tables 23 through 31 the following notations are used: N = sample size, X = independent variable, Y = dependent variable, a = Y intercept, b = coefficient of regression, r = product-moment correlation coefficient, Σx^2 = sum of squares of deviations of X, Σy^2 = sum of squares of deviations of Y, and Σxy = sum of cross products of deviations of X and Y.

RECOMMENDATIONS

Several ways in which a collecting program such as ours might be improved and provide better sampling and understanding of the area studied are:

1. Collect additional physical data, such as current velocity;
2. Make replicate tows through the collecting site (preserving the material from each tow separately);
3. Establish replicate collecting sites nearby;
4. Use a larger seine for longer tows in deeper water to supplement the collecting;
5. Collect at several stages of the tide, at midday and at night, and during various phases of the moon;
6. Sample for a longer period of time;
7. Make a special effort to gather additional biological data, such as information on spawning, fecundity, food habits, incidence of ectoparasitism; and
8. Use field and laboratory data sheets from which data can be key punched directly without transcription.

A program incorporating the methods used in this study and the above recommendations should provide

Table 23.—Carapace length-carapace width, carapace length-weight, and carapace width-weight regression statistics for N = 352 specimens of *Arenaeus cribrarius*.

X	Y	a	b	r	Σx^2	Σy^2	Σxy
CW	CL	−1.1686	0.4659	0.996	160,001.63990	34,989.03111	74,550.70835
CL	CW	2.7690	2.1307	0.996	34,989.03111	160,001.63990	74,550.70835
log CW	log W	−4.7894	3.3004	0.977	15.95073	181.96342	52.64344
log CL	log W	−3.4380	3.1801	0.983	17.38521	181.96342	55.28680

	CW (mm)	CL (mm)	W (g)
Mean	38.59	16.81	7.99
Range	7.0-140.8	4.0-65.6	0.07-222.9

Table 24.—Length-length and length-weight regression statistics for $N = 215$ specimens of *Anchoa mitchilli.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	3.7405	1.0208	0.980	7,021.48493	7,610.26633	7,167.23298
SL	TL	2.3699	1.1657	0.963	7,021.48493	10,290.75656	8,185.22423
FL	SL	−1.7622	0.9418	0.980	7,610.26633	7,021.48493	7,167.23298
FL	TL	−1.0110	1.1243	0.967	7,610.26633	10,290.75656	8,556.17275
TL	SL	1.4286	0.7954	0.963	10,290.75656	7,021.48493	8,185.22423
TL	FL	4.1155	0.8314	0.967	10,290.75656	7,610.26633	8,556.17275
log SL	log W	−6.0330	3.6360	0.951	0.66723	9.75842	2.42602
log FL	log W	−6.4963	3.8170	0.951	0.60589	9.75842	2.31271
log TL	log W	−6.2989	3.6100	0.941	0.66381	9.75842	2.39633

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	45.53	50.22	55.45	1.08
Range	27.5-59.9	30.9-64.4	33.4-77.0	0.20-2.78

Table 25.—Length-length and length-weight regression statistics for $N = 341$ specimens of *Fundulus majalis.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	TL	1.7211	1.1722	0.999	39,435.90452	54,339.91062	46,226.10678
TL	SL	−1.3361	0.8507	0.999	54,339.91062	39,435.90452	46,226.10678
log SL	log W	−5.1305	3.2532	0.995	3.31912	35.50605	10.79770
log TL	log W	−5.5353	3.3303	0.995	3.16801	35.50605	10.55051

	SL (mm)	TL (mm)	W (g)
Mean	45.05	54.52	2.19
Range	26.0-84.1	31.8-98.5	0.25-12.25

Table 26.—Length-length and length-weight regression statistics for $N = 500$ specimens of *Menidia menidia.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	3.4715	1.0872	0.997	27,732.99210	33,001.74800	30,151.30480
SL	TL	5.7405	1.1396	0.991	27,732.99210	36,673.69960	31,604.49710
FL	SL	−2.7378	0.9136	0.997	33,001.74800	27,732.99210	30,151.30480
FL	TL	2.2339	1.0464	0.993	33,001.74800	36,673.69960	34,533.23480
TL	SL	−3.7872	0.8618	0.991	36,673.69960	27,732.99210	31,604.49710
TL	FL	−1.0206	0.9416	0.993	36,673.69960	33,001.74800	34,533.23480
log SL	log W	−5.0377	3.0341	0.929	1.25294	13.36788	3.80155
log FL	log W	−5.4685	3.1716	0.934	1.15954	13.36788	3.67758
log TL	log W	−5.7295	3.2553	0.943	1.12077	13.36788	3.64845

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	64.72	73.83	79.49	3.00
Range	30.8-88.9	35.4-96.7	38.0-107.0	0.24-7.48

Table 27.—Length-length and length-weight regression statistics for $N = 500$ specimens of *Trachinotus carolinus.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	1.2582	1.1215	0.999	116,132.82810	146,309.33380	130,241.53720
SL	TL	−0.6558	1.3240	0.998	116,132.82810	204,204.72070	153,753.67220
FL	SL	−1.0732	0.8902	0.999	146,309.33380	116,132.82810	130,241.53720
FL	TL	−2.1288	1.1802	0.999	146,309.33380	204,204.72070	172,666.97750
TL	SL	0.5817	0.7529	0.998	204,204.72070	116,132.82810	153,753.67220
TL	FL	1.8689	0.8456	0.999	204,204.72070	146,309.33380	172,666.97750
log SL	log W	−4.9662	3.2714	0.996	20.71864	223.58965	67.77955
log FL	log W	−5.3659	3.3869	0.996	19.34027	223.58965	65.50392
log TL	log W	−5.2538	3.2184	0.996	21.41597	223.58965	68.92533

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	27.94	32.59	36.33	1.42
Range	11.8-93.0	14.1-104.1	15.7-123.9	0.03-24.88

Table 28.—Length-length and length-weight regression statistics for $N = 45$ specimens of *Trachinotus falcatus.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	1.6501	1.0962	0.9997	5,485.89911	6,596.88311	6,013.79711
SL	TL	0.1357	1.2980	0.9988	5,485.89911	9,264.20800	7,120.66133
FL	SL	−1.4883	0.9116	0.9997	6,596.88311	5,485.89911	6,013.79711
FL	TL	−1.8078	1.1837	0.9989	6,596.88311	9,264.20800	7,808.62933
TL	SL	−0.0483	0.7686	0.9988	9,264.20800	5,485.89911	7,120.66133
TL	FL	1.5879	0.8429	0.9989	9,264.20800	6,596.88311	7,808.62933
log SL	log W	−4.0249	2.7452	0.9429	1.17563	9.96602	3.22731
log FL	log W	−4.4235	2.8910	0.9393	1.05202	9.96602	3.04141
log TL	log W	−4.3651	2.7614	0.9468	1.17158	9.96602	3.23522

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	24.00	27.96	31.29	1.03
Range	12.1-59.4	14.3-66.8	16.2-75.9	0.09-8.66

Table 29.—Length-length and length-weight regression statistics for $N = 291$ specimens of *Menticirrhus littoralis.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	TL	1.2032	1.2172	0.998	114,966.97810	171,061.35680	139,935.44470
TL	SL	−0.7740	0.8180	0.998	171,061.35680	114,966.97810	139,935.44470
log SL	log W	−4.7160	2.9514	0.992	7.60448	67.38193	22.44407
log TL	log W	−5.0851	3.0019	0.991	7.34690	67.38193	22.05480

	SL (mm)	TL (mm)	W (g)
Mean	48.96	60.79	2.88
Range	19.2-149.1	24.4-181.2	0.10-45.90

Table 30.—Length-length and length-weight regression statistics for $N = 48$ specimens of *Mugil cephalus.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	1.6494	1.1462	0.9997	287,624.41670	378,110.61480	329,671.25420
SL	TL	−0.2732	1.2703	0.9997	287,624.41670	464,347.77310	365,360.01750
FL	SL	−1.3811	0.8719	0.9997	378,110.61480	287,624.41670	329,671.25420
FL	TL	−2.0735	1.1080	0.9998	378,110.61480	464,347.77310	418,941.18560
TL	SL	0.2608	0.7868	0.9997	464,347.77310	287,624.41670	365,360.01750
TL	FL	1.9075	0.9022	0.9998	464,347.77310	378,110.61480	418,941.18560
log SL	log W	−5.1821	3.2163	0.9995	9.39197	97.25856	30.20757
log FL	log W	−5.5090	3.2681	0.9995	9.09758	97.25856	29.73201
log TL	log W	−5.4259	3.1764	0.9996	9.63288	97.25856	30.59741

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	87.69	102.16	111.12	49.31
Range	18.2-328.0	21.8-370.0	22.3-413.0	0.07-586.0

Table 31.—Length-length and length-weight regression statistics for $N = 394$ specimens of *Mugil curema.*

X	Y	a	b	r	Σx^2	Σy^2	Σxy
SL	FL	0.5761	1.1722	0.9985	470,299.87390	648,206.35520	551,308.74100
SL	TL	−0.7066	1.2848	0.9997	470,299.87390	776,685.93360	604,216.83340
FL	SL	−0.3563	0.8505	0.9985	648,206.35520	470,299.87390	551,308.74100
FL	TL	−1.1853	1.0931	0.9986	648,206.35520	776,685.93360	708,547.91860
TL	SL	0.5739	0.7780	0.9997	776,685.93360	470,299.87390	604,216.83340
TL	FL	1.2302	0.9123	0.9986	776,685.93360	648,206.35520	708,547.91860
log SL	log W	−5.1563	3.2558	0.9984	30.99242	329.57610	100.90500
log FL	log W	−5.4521	3.2860	0.9979	30.39528	329.57610	99.87731
log TL	log W	−5.4166	3.2148	0.9986	31.79767	329.57610	102.22395

	SL (mm)	FL (mm)	TL (mm)	W (g)
Mean	44.79	53.08	56.83	6.66
Range	19.1-130.4	23.0-155.5	24.1-168.0	0.10-49.60

adequate data for developing basic models of either the shallow-water estuarine or surf-zone ichthyofauna occurring over shell-hash, sandy, or muddy bottoms and should be useful both in identifying natural perturbations and artificial stresses and in predicting their effects.

CONCLUSIONS AND SUMMARY

1. Fifty-one collections were made in the surf and 36 in the tidal pool from which some 512 specimens of swimming invertebrates representing at least 17 species and 5,095 specimens of bony fishes representing 41 species were collected.

2. The surf and tidal pool collections differ significantly with respect to number of species per collection when averaged over both years and all seasons.

3. Winter and summer differ significantly in number of species per collection.

4. Both the main effect of location and the location-by-season interaction show highly significant differences in number of specimens per collection.

5. There is a highly significant difference between the average number of specimens per collection in the surf versus the tidal pool for those collections made in winter and a significant difference for summer.

6. There is a highly significant difference between years for the total weight of fishes per collection. This is due in part to the capture during the first year of a number of comparatively large specimens of *Mugil cephalus* and a single specimen of *Pogonias cromis* weighing more than 1.2 kg.

7. The main effect of location shows a highly significant difference in total weight of fishes per collection and the location-by-season interaction is significant.

8. There is a highly significant difference between surf and tidal pool in average total weight of fishes per collection for winter and summer and a significant difference for spring.

9. Six species of fishes (*Anchoa mitchilli*, *Fundulus majalis*, *Menidia menidia*, *Trachinotus carolinus*, *Menticirrhus littoralis*, and *Mugil curema*) accounted for 94% of the specimens of fishes collected and 72% of the ichthyomass. One species, *Arenaeus cribrarius*, made up 82% of the swimming invertebrate specimens and 75% of the mass of swimming invertebrates.

10. Species were ranked as to "importance." In the surf and tidal pool combined the order of decreasing "importance" for the most abundant species was *Menidia menidia*, *Arenaeus cribrarius*, *Trachinotus carolinus*, *Menticirrhus littoralis* and *Mugil curema*, *Anchoa mitchilli*, and *Fundulus majalis*.

11. Water temperature and its square correlated significantly with number of specimens for each of five of the most important species (*Arenaeus cribrarius*, *Anchoa mitchilli*, *Menidia menidia*, *Trachinotus carolinus*, and *Menticirrhus littoralis*) collected in the surf. Height of sea was significantly correlated with occurrence for *A. mitchilli* and *M. littoralis*; and a significant negative correlation existed between salinity and number
specimens for *M. menidia*.

12. The prediction equation for monthly av
number of specimens per collection contained
temperature, the square of water temperature,
salinity as independent variables for *Menidia me*
but only water temperature appeared in the equatio
all other species examined except *Anchoa mitc*
which contained visibility of Secchi disc (in additio
water temperature) as an independent variable.

13. *Arenaeus cribrarius* has a prolonged spa
period; ovigerous females were collected as early as
June, recently spawned females as late as
September, and small specimens (20 mm CW or sm
from May through October.

14. Ripe specimens of *Menidia menidia* were obse
from late March to early June. Specimens of *M. me*
50 mm SL or smaller were rarely collected. Becaus
virtual absence of small individuals of *M. menidia*
not appear to be related to the method of collection
species presumably occupies a habitat other tha
surf zone during its early life history.

15. *Trachinotus carolinus* has a prolonged spa
period; specimens 22 mm SL or smaller appeared
catch from mid-April through late October.

16. Specimens of *Menticirrhus littoralis* less th
mm SL were collected from June through Novemb
dicating an extended spawning period.

17. The apparent absence of juveniles of *Parali*
squamilentus in the waters of South Carolina befor
is a result for the most part of inadequate collect

18. *Sphoeroides spengleri* is reported for the firs
from the waters of South Carolina.

19. Relationships of carapace length to carapace
and these measurements to weight are presented
decapod crustacean *Arenaeus cribrarius*; an
relationships of lengths and lengths to weigh
presented for eight species of fishes.

20. Recommendations for improving surveys
to the one reported herein are given.

21. Stochastic effects seem to be important in
mining the catch in the surf and associated tidal
sandy beaches.

22. Species inhabiting the surf zone must be
cope with wide ranges in turbulence, turbidity,
tities of suspended particles in the medium,
velocity, and bottom characteristics. In addition
above factors, a number of meteorological and se
changes are superimposed producing variati
temperature and salinity. Highly motile speci
move into or out of the surf zone dependin
prevalent conditions. This may account in part f
of the variations in catch.

23. The macrofauna of the tidal pool is a depa
derivative of the surf zone.

24. Species collected in the tidal pool were p
attracted there to some degree by their d
ecological requirements and tolerances. In a
larger individuals tend to avoid being trapped
pools, whereas smaller ones (of species

rachinotus carolinus* and *Mugil curema*) may actively ek them as havens which are relatively free of rs. Species inhabiting tidal pools are subjected to fluctuations in temperature and salinity.

ACKNOWLEDGMENTS

We are grateful to Thomas D. Bryce, Michael N. ohen, Bruce A. Daniels, Charles H. Farmer, Donna arper, J. S. Hopkins, Mark B. Maddox, James F. ney, William A. Roumillat, and Barry Stamey for ssistance in the field. Thomas D. Bryce, Charles H. armer, and James F. McKinney aided in numerous processing some of the collections. Robert L. (University of South Alabama) identified the pecimen of *Sphoeroides spengleri*. James F. McKinney nd William A. Roumillat coded and checked data for lyses by computer. B. M. Martin of the Department of Radiology, Medical University of South arolina, made the radiographs used in this study. R. C. , C. B. Loadholt, and M. C. Miller, III, of the ment of Biometry, Medical University of South arolina, provided assistance on statistical methods and ccess to computer facilities. This study was supported by a traineeship grant to James K. Dias from the ment of Health, Education and Welfare, Public ealth Service, National Institutes of Health. Dale R. alder (South Carolina Wildlife and Marine Resources ment, SCWMRD) verified the nomenclature used rtebrates. Alice E. Charest, Karen R. Swanson, nd Peter B. Laurie (all of SCWMRD) assisted with the script preparation. Charles A. Barans RD), Peter J. Eldridge (SCWMRD), C. B. oadlt, John J. Manzi (SCWMRD), and John W. ucker, Jr. (North Carolina State University) reviewed nuscript.

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Aquacultural Economics Bibliography

John Vondruska

October 1976

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Aquacultural Economics Bibliography

JOHN VONDRUSKA[1]

ABSTRACT

This aquacultural economics bibliography includes recent published and some unpublished United States and foreign literature (originally in or translated into English). Based upon U.S. aquacultural activity and interests, the 262 entries are listed alphabetically within eight categories: catfish, trout, salmon, oysters and other mollusks, shrimp and other crustaceans, other animal species, seaweeds, and general. Included literature concerns production economics, methodology, demand, supply, markets and marketing, institutions, constraints, state of the art, investment analysis, data, and other subjects. Some entries are general, or primarily descriptive, or of primarily noneconomic content.

INTRODUCTION

Contents

The following discussion is intended to help users find ntries of interest. An author index follows the entries. Entries are alphabetized by author name in eight categories:

Catfish	1- 66	(also 176)
Trout	67- 81	(also 38, 51, 52, 176, 201)
Salmon	82- 97	(also 176)
Oysters and other mollusks	98-120	(also 85, 176, 245)
Shrimp and other crustaceans	121-144	(also 171, 176)
Other animal species	145-161	
Seaweeds	162-169	(also 225)
General (not species specific)	170-262	

Enterprise budgets (tables or statements of revenue, osts, and returns for a specified period of operation or or a production cycle) are available for most of the plant and animal species being cultured. These statements vary in purpose, sophistication, and completeness.

Investment, optimizing, systems analysis, engineering design, benefit cost, and other models have been applied to aquaculture, including the following examples. Mange nd Thompson applied an investment decision model to atfish farming. Pinchuk applied linear programing to optimize fish culture production in the Donetsk region, Russia. Engineering design and systems analysis models ave been applied to closed system oyster culture by Costello, Marsh, and others. This bibliography includes benefit cost analyses of salmon hatchery programs by Bollman; Richards; and Wahle, Vreeland, and Lander. Johnston and Allen, and Schuur, Allen, and Bottsford discussed applications of computerized budget, systems, and engineering design models to lobster culture. Shang has applied net present value investment models to prawns, baitfish, and eel in separate studies.

Market functions, problems, surveys, channel identification, and other marketing matters are the concern of entries in this bibliography relating to catfish, trout, pan-sized salmon, oysters, crawfish, baitfish, and other fish.

Empirical demand relationships have been estimated for products dependent on aquaculture. These products vary in their degree of similarity to like or competing products dependent on conventional capture (natural or wild stock) fisheries. Miller and Nash, and Raulerson and Trotter reported results for catfish. Agnello and Donnelley, and Charbonneau provided simultaneous equation results for oysters. Ffrench's results relate to seaweeds, and Shang's to eels. The multination analysis of all fishery products by Bell et al. included some cultured products or fish.

Regional, natural resource, and/or economic development in relation to aquaculture have been considered by many authors in overview, prognostic, and analytical reports involving different approaches and disciplines. Among the treatments and approaches most familiar to economists are those of Gates on less developed countries; Bell and Canterbery on technology tranfer; Landis on technology assessment; and those relating to traditions, adoptive or innovative behavior, and the effects of social, political, and economic institutions in oyster culture.

Some of the papers concerning the legal and institutional aspects of aquaculture are included in this bibliography, for example, salmon—Manhnken, Novotny, and Joyner; oysters—Matthieesen; general (not species specific)—Cowan, Henry, Rutka, and Trimble.

Aquaculture and pollution pose a variety of problems. Odum analyzed the relationships and effects. Revenue, cost, and return figures for various systems are provided by Allen, Conversano, and Colwell; Bond et al.; Palmer; Smith and Huguenin; Welsh; and Yee. Kildow and Huguenin examined broader legal, social, political, and economic considerations, including consumer acceptance and marketing strategies in relation to produced goods and services. Also, see entry 173.

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Many writers discussed the risks of aquaculture, and Webber's treatment is the most complete. Secretan discussed risk management as part of an insurance program for an aquacultural enterprise.

Some papers included in this bibliography relate primarily to the outlook, problems, constraints, development rationale, and biological and technical aspects of aquaculture. A few papers and reports are included because they provide data on production, acreage, consumption, and other variables. Bibliographies relating to trout (Meade), to biology of most species (in books by Bardach, Ryther, and McLarney; Iversen; Hammack's bibliography), and to economic evaluations of shellfish aquaculture (Johnston and Collingsworth) may be helpful to some users of this bibliography.

Sources

Several sources of literature were used. Requests were sent to various individuals and institutions. Recent issues of periodicals were searched, for example, The Commercial Fish Farmer and Aquaculture News (and predecessor periodicals), Aquaculture, Marine Fisheries Abstracts (formerly Commercial Fisheries Abstracts), and Aquatic Sciences & Fisheries Abstracts (and predecessors, cited as ASFA). In addition, certain computer-access data bases were examined. Listed in order of usefulness and fruitfulness for this bibliography they are: National Technical Information Service (NTIS), Selected Water Resource Abstracts (SWRA), Aquaculture (AQ, to which this bibliography's entries are now added), and the National Agricultural Library (CAIN), all of which are accessible on the NOAA Oceanic and Atmospheric Scientific System (OASIS). For foreign literature, the National Marine Fisheries Service (NMFS, formerly Bureau of Commerical Fisheries, BCF) Office of International Fisheries library files of index cards were searched to obtain possible entries. As appropriate, more specific addresses and information are given for some sources to assist the user in obtaining cited literature.

This bibliography could be revised in several ways. It is based on a nonexhaustive literature search, and the germane literature is growing. The author would a
preciate receiving reports and papers to include in
possible revised version of the bibliography and to he
answer inquiries. These reports and papers, along wi
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Washington, DC 20235

CATFISH

001
Adrian, J. L.; McCoy, E. W.
1971.
Costs and returns of commercial catfish production in Alabama.
Auburn Univ., Agri. Exp. Sta., Bull. 421, 23 pp.
The primary objectives of the study were to evaluate inputs, costs, and returns, and to determine the optimum size for commercial catfish operations in Alabama. A purposive sample of 58 growers was obtained. Grouped data are shown for small (under 5 acres), middle sized (5 to 10 acres) and large operations (over 10 acres). Data for the following variables are itemized: investment, labor, annual costs (variable, fixed, other, and total), gross receipts, and returns (to various owned factor combinations and as a percentage of investment). The data did not permit determination of the optimum size of operation, but economies of scale with respect to acreage are shown in tables and in a regression of cost per acre on firm acreage. Concomitantly, returns increased. The analysis also considers other comparisons and aspects of the industry.
Subject descriptors:
Catfish; revenue; costs; returns; economies of scale; sample data.

002
Adrian, J. L.; McCoy, E. W.
1972.
Experience and location as factors influencing income from commercial catfish enterprises.
Auburn Univ., Agri. Exp. Sta., Bull. 437, 28 pp.
Growth of catfish farming began in Alabama in 1967, but supply-demand conditions soon reduced prices. Disease and oxygen deficiency reduced yields. Experienced producers were found to receive 6 cents more per pound of catfish, their output was 100 pounds more per acre, and their net returns were about $100 per acre. Efficient use of resources and maximum production increased net returns. Commercial production in the central part of the State allowed some cost reduction, apparently because of concentration of growers.
Subject descriptors:
Catfish; enterprise comparison.

003
Anonymous.
1974.
Catfish farm production survey, 1973.
U.S. Dep. Commer., Natl. Mar. Fish. Serv. (Room 147, Post Office and Courts Building, Little Rock, Arkansas 72201), mimeographed, 3 pp.
Results of a 1973 survey of catfish farming by the Soil

Conservation Service are reported, including information on
acreage, production and disposition. Pond acreage totaled 54,633
acres, and 47.95 million pounds were harvested from 29,942 acres.
Adding production from raceways, cages and tanks, 1.86 million
pounds, brought the total to 49.81 million pounds valued at
$26.19 million. Disposition data from a fewer number of States
indicates that 32% went to processors, 24% went to local
retailers, 31% went to live haulers, and 13% went to pay lakes,
of which the last two categories are thought to represent the
recreational market.
Subject descriptors:
Catfish; survey data.

004
Anonymous.
1973.
Catfish farming risky, larger farms more profitable, study shows
Amer. Fish Farmer World Aquacult. News 4(3): 9.
Results of a study are summarized. (See annotation under Carrol
Garner.)
Subject descriptors:
Catfish; revenue; costs; returns; economies of scale; sensitivit
analysis.

005
Anonymous.
1971.
The catfish industry--1971: an economist leads a semina
discussion.
Amer. Fish Farmer World Aquacult. News 2(4): 12-14, 27.
This article is based on a seminar in which J. E. Greenfield
Regional Economist for the Southeast Region of National Marin
Fisheries Service, was the principal speaker. Among the items o
economic interest is a discussion of the break-even cost fo
Delta farmers (28 cents per pound). The 1971 net price paid
however, at the farm level was 26 cents per pound of catfis
sold. Raceway culture, water temperature, imported catfish vs
domestic catfish competition, and disease treatment are discusse
in a question and answer session. The market for catfish i
in the food service area.
Subject descriptors:
Catfish; marketing.

006
Anonymous.
1970.
Catfish profit potential: $179 per acre.
Fish Farming Ind. 1(1): 12.
This article is based on comments made by Mark Lupher

Greenville, Miss., catfish farmer, to the Convention of the Catfish Farmers of America. Contrary to some statements of cost, Lupher counts interest on land, construction, and equipment investments, as well as interest on working capital before computing net profit. Per acre revenue, cost, and net profit data are presented for three rates of output (1,000, 1,500, and 2,000 pounds of catfish per acre), with cost variations among them being due to differences in feed, fingerlings, and hauling expenses. Various expense items are discussed, including factors that could cause revenue, costs, and returns to depart from the amounts shown. The data are based on Lupher's operation and others with which he is familiar.
Subject descriptors:
Catfish; revenue; costs; returns.

007
Anonymous.
1973.
Cost-returns--catfish food production (40 acre operation).
U.S. Dep. Agri., Soil Conserv. Serv., unpubl. table, 2 pp. Obtain from Mayo Martin, Ext. Biologist, Bur. Sport Fish. Wildlife, Fish Farming Exp. Sta., P. O. Box 860, Stuttgart, AR 72160.
Initial investment costs, annual costs and returns, computational assumptions, and other data are given for a 40-acre operation (with four 1-acre and four 7-acre ponds). Gross returns and net returns to land and management, average net return per acre, and production costs per pound are given for three levels of output (1,500, 1,200, and 2,000 pounds per acre).
Subject descriptors:
Catfish; revenue; costs; returns.

008
Anonymous.
1976.
Catfish farming--how to make it profitable.
Commercial Fish Farmer Aquacult. News 2(3): 9-15.
This article presents comments made by four farm operators at the workshop on the economics of catfish farming at the annual convention of the Catfish Farmers of America, February 4-7, 1976, Biloxi, Miss. Various cost, technique, management and other information is provided for the four operations. One operator indicated that catfish farming is less subject to uncontrollable factors (such as weather) than such land-based crops as wheat, beans and cotton.
Subject descriptors:
Catfish; costs; returns; techniques.

009
Anonymous.
1971.
Culcat Corporation: an investment study and analysis.
Bradley Univ., Peoria, Ill., Dep. Ind. Eng., Eng. Adm. Class of 1971. Obtain copies from Steve Maple, Culcat Proj. Chairman, 3334 W. Wilshire Dr., Peoria Ill., 61614 ($10 per copy), 169 pp.
This report is a class project prepared to fulfill requirements of the engineering administration graduate program, Bradley University. It includes chapters on administration, marketing, finance, plantsite location, manufacturing operations, technological and biological reference information, and bibliography, all as related to the formation of a hypothetical catfish-producing business. A differentiated product; sales promotion, cost, and forecasts; and the U.S. market situation are discussed. Five years of costs and returns (by month) and a break-even diagram are shown for the firm. Among the factors considered (with data) to demonstrate the rationale for plant location were utility, labor, tax, government assistance, transportation, and other costs; amenities; and locations of markets and supplies. The chapter on operations includes plans, operating data, item costs, and a cost-summary table for four sizes of plant, with growing, feeding, harvesting, and processing costs separated.
Subject descriptors:
Catfish; revenue; costs; returns; marketing; forecasts; technology; techniques; biology; processing.

010
Anonymous.
1969.
Proceedings, Commercial Fish Farming Conference, Jan. 27-28, 1969, Athens, Ga.
Univ. Ga., Coop. Ext. Serv. and Inst. Community Area Dev., 85 pp.
Some of the papers are annotated separately. Topics include: overview, pond construction and water use, cultural practices (growth of fingerlings and food fish, disease and parasite control, growth response to feed, harvesting), processing, marketing, profit potential, and economic characteristics and potential.
Subject descriptors:
Catfish; biology; techniques; facilities; processing; marketing; outlook.

011
Anonymous.
1971.
Proceedings, First Annual Kerr Foundation Fish Farming Conference, Feb. 26, 1971, Poteau, Okla.
Kerr Foundation, Poteau, Okla., 41 pp.
Presentations by speakers and panelists are compiled. Topics

include: fish pond construction, water quality and quantity, fingerling production, cage culture, culture from fingerlings to food fish, diseases and parasites, marketing, fish pond biology, and aquatic vegetation control. Briefly, items of economic interest include some comparisons of production methods, factor usage, and costs.
Subject descriptors:
Catfish; techniques; methods; biology; marketing; costs.

012
Anonymous.
1972.
Proceedings, Second Annual Kerr Foundation Fish Farming Conference, March 10, 1972, Poteau, Okla.
Kerr Foundation, Poteau, Okla., 55 pp.
Various aspects of catfish farming are discussed in five presentations, panel discussions, and question and answer sessions. Topics include basic aspects of catfish nutrition, recognition and treatment of the common catfish diseases, catfish marketing problems, cage culture of channel catfish (including costs), and economics of production in ponds. Briefly, the economic concerns were: supply and demand of various catfish species, consumer preferences, production and investment costs, depreciation, interest rates, net profit and risk in investment. An article by Collins is separately annotated in this bibliography.
Subject descriptors:
Catfish; biology; methods; marketing; costs; returns; risks; techniques.

013
Anonymous.
1971.
Producing and marketing catfish in the Tennessee Valley.
Conference Proceedings, June 30-July 1, 1971, Knoxville, Tenn., T.V.A., Bull. Y-38, 96 pp.
Several of the papers include tables and discussion on production costs using different methods (ponds, raceways and cages) of farming. Marketing is considered at several stages, as well as in terms of product form. Other topics include: financing, nutrition, disease, new and needed developments, and factors for prospective investors and managers to consider. The focus of the conference was on private catfish farming, with only incidental recognition being given to sport and commercial fishing from public waters.
Subject descriptors:
Catfish; costs; returns; marketing; financing; general description.

014
Anonymous.
1972.
Raceways versus ponds: how they compare costwise, profitwise.
Fish Farming Ind. 3(1): 12-13.
Summarized are results of a Georgia study (by E. Evan Brown and Jerry L. Chesness, University of Georgia; Samuel R. Chapman, Soil Conservation Service). Hypothetical 1970 investment costs, annual costs and returns, computational assumptions, and other information are given to compare ponds and raceways for raising catfish. The comparison is based on four 5-acre ponds and one 20-segment raceway, both operations producing 114,000 pounds per year. Three output prices (all in excess of average costs for both methods, about $0.28/lb.) are used to show the effect on gross returns and net returns to management, holding costs constant. Feed and fingerlings are the major cost items for both methods and they are both higher for raceways, offsetting the advantage raceways have in lower initial investment cost, lower pumping costs, and lower havesting costs.
Subject descriptors:
Catfish; revenue; costs; returns; method comparison.

015
Anonymous.
1970.
Report to the fish farmers (the status of warmwater fish farming and progress in fish farming research).
U. S. Dep. Inter., Bur. Sport Fish. Wildl., Resour. Publ. 83, 124 pp.
This report is essentially similar to Second report to fish farmers, annotated under Meyer, Fred P. and others.
Subject descriptors:
Catfish; general description.

016
Anonymous.
1972.
A statistical reporting system for the catfish farming industry, methodology and 1970 results.
Univ. Ark., Ind. Res. Ext. Cent., and Dep. Agri. Econ. Rural Sociol. (subcontractor), Econ. Dev. Adm., Tech. Assist. Proj. Rep. 99-6-09044-2, 233 pp.
The report gives information that was collected to develop and test the proposed system. This information relates to various aspects of farming, processing, marketing, and sources of supplies; for example, data on farm-pond acreage, production (for food and for fingerlings), operators, cages and raceways, market outlet (processor, retailer, and live-hauler), supply source, and disposition.
Subject descriptors:
Catfish; production data; processing; marketing; methods; markets; acreage data.

017
Anonymous.
1972.
What's ahead for catfish.
Fish Farming Ind. 3(3): 10-12.
The article presents some of the comments made by Tennessee Valley Authority (TVA) economist, Carl Madewell, to fish producers. Growth in demand for catfish is discussed, along with advantages to marketers and producers. Data on estimated production indicate an increase from 0.3 million pounds worth $0.1 million in 1960 to 54 million pounds worth $18.9 million in 1970. Estimated itemized cost and return information is shown for three kinds of farming operations: catfish in ponds (40-acre farm with 80,000 pounds of output annually), and catfish or trout in raceways (200,000 pounds of output annually). In a comparison of catfish pond and raceway operations, feed accounts for about 40% and 47% of the annual cost, respectively; fingerlings, 21% and 19%; and annual investment costs (amortized capital costs), 18.5% and 9%. Under the specified assumptions, cost per pound (round or whole weight basis) for both systems came to about 34 cents, and a survey of actual farm operations in the TVA area revealed costs in the 24- to 71-cent range, with more than half of the operators achieving a cost of 31 cents per pound or less.
Subject descriptors:
Catfish; production data; revenue; costs; returns; method comparison.

018
Ayers, James W.
1971.
Marketing problems demand production efficiency and sales promotion (The catfish market: problems and promise).
Amer. Fish Farmer World Aquacult. News 2(4): 10, 16-17.
Several ways of improving catfish production and market approach are discussed. The growth of catfish farming from more than 250 acres of water devoted to catfish culture in 1960 to more than 250,000 acres in 1971 is cited. The price per pound of catfish delivered to a processing plant is about 30 cents while the cost of processing the catfish is 65 cents. There are also brokerage fees, transportation costs, and markups at the retail level. Efficiency in producing, harvesting, transporting, and marketing of the finished product is stressed. Causes for most catfish processing plants operating at a loss include high expenses for operation and overhead, high cost of raw materials, excess labor costs, unnecessary mechanical breakdowns, and excess waste of raw materials (catfish).
Subject descriptors:
Catfish; marketing.

019
Bartonek, Frank A.
1972.
Catfish farming.
Amer. Fish Farmer World Aquacult. News 3(8): 4-7. (Reprinted from Farmland News.)
Information on the development of catfish farming, farming methods, and some individual operations is provided on the basis of the reporter's visits and interviews. Business risks include poor management (said to be responsible for as high as 80% of the catfish business failures), lack of technical know how, absentee rather than on-farm owner (manager), location, operation on too large a scale when a pond is being tried and experience is being gained, and other risks associated with an industry in the early stages of development. Discussed briefly are historical developments, feeds, yield variations (1,000 pounds of fish per acre of pond for new growers and 2,000 pounds per acre for experienced growers), feed conversion ratios, research by various individuals and institutions, laws, and other matters.
Subject descriptors:
Catfish; risks; history.

020
Billy, Thomas J.
1973.
Pond-grown catfish in the United States: present situation and future opportunities.
Paper presented to the FAO Technical Conference on Fishery Products, Dec. 4-11, 1973, Tokyo. FAO, FII: FP/73/E-33, 13 pp.
Industry development, activity from farm to consumer, organization, products, markets, and problems are described briefly. Among the factors accounting for development of a pond-grown catfish industry are stability of wild catfish output, the established product market, adaptability of catfish to culture, timely Federal Government R&D, the abundance of low-cost freshwater in the U.S. south-central region, and available surplus agricultural land for pond sites. Key farm management problem areas are ponds, fingerlings, production limits (growing season, feeds, etc.), diseases, parasites, and harvesting. A schema or flow chart shows processing and marketing steps. The industry faces several problems in the future.
Subject descriptors:
Catfish; processing; marketing; technology; general description; industry development.

021
Billy, Thomas J.
1969.
Processing pond-raised catfish.
Proceedings, Fish Farming Conference, Jan. 27-28, 1969, Athens, Ga. Univ. Ga., Coop. Ext. Serv., Inst. Community Area Dev., pp. 42-48.

This paper indicates the general considerations involved in moving farm-reared catfish from the pond to and through a processing plant for distribution to market. Each step along the way is discussed in general terms. Particular emphasis is placed on the special considerations and interrelations between the various operations, and on proper design, layout, and equipping of a processing plant. The lowering of costs of production, processing, and marketing is one of the major limiting factors to the continued orderly development of the processing sector of the industry.
Subject descriptors:
Catfish; technology; processing; general description.

022
Brown, E. Evan; Holemo, Fred J.; Hudson, Horace.
1973.
What the Georgia fee fishing survey reveals.
Fish Farming Ind. 4(3): 10, 12 and 13.
Initial results of a 1972 survey of 23 Georgia catfish fee fishing operators are reported, along with the discussion of certain factors necessary to the success of such business. Among these factors are pond site selection, pond and structure design, water quality and quantity, fish culture, species selection, feeding, fertilization, and control of predators and disease. Itemized sample budget data are given for revenue, costs and returns, including survey average and range data for certain items of expense. On the average, fishout pond operators were open for business 200 days per year. Income came from fees only, not from sales of sundries and tackle, which proved unprofitable. After deducting variable and fixed expenses, including interest on investment, the net returns to family labor and management averaged $2,003 per acre.
Subject descriptors:
Catfish; recreation; fee fishing; survey data; revenue; costs; returns.

023
Brown, E. Evan; LaPlante, M. G.; Covey, L. H.
1969.
A synopsis of catfish farming.
Univ. Ga., Coll. Agri. Exp. Sta., Res. Bull. 69, 50 pp.
Contents: spawning and hatching, chemical control of diseases and parasites, pond construction and water quality control, feeding, harvesting, marketing, expected costs and returns of channel catfish farming, summary and observations, and literature cited. Market outlets for commercial growers include: live fish (for pay-lake operators), now the presently highest priced and dominant market; local markets, upon which small operators depend; and volume food-fish markets. Gross and net returns per acre for various fish and agronomic field crops are cited (1966, Arkansas data). Itemized investment and annual costs, and annual

returns are shown and discussed. The effects of two feed conversion ratios (1.87:1 and 2.0:1) and two sets of assumptions are indicated, along with the effects of different product prices (range: 25 cents to 65 cents/lb.) on net returns. Organized catfish markets are lacking, investment costs are substantial, risks are many, industry expansion seems likely, if improved cultural practices are adopted, and research by several government agencies has helped to overcome problems.
Subject descriptors:
Catfish; general description; revenue; costs; returns; outlook; markets.

024
Buettner, Howard J.
1972.
Fish farming in twelve south central states (species, acreage and number of farmers).
Natl. Mar. Fish. Serv., Current Fish. Stat. No. 6038, 20 pp.
Results of a 1969 survey of fish farmers in 12 states are reported. Of 1241 respondents engaged in fish farming on 75,413 acres, 804 were growing adult catfish (on 30,330 acres), 429 were growing fingerling catfish (on 6,782 acres) and 292 were growing minnows (on 26,866 acres). Some 23 aquatic fauna were reported as being grown.
Subject descriptors:
Survey data.

025
Collins, Charles M.
1972.
Cage culture of channel catfish (1971 experiment).
Paper presented to the Fourth Annual Convention of the Catfish Farmers of America, February 3-5, 1972, Dallas, Tex. Kerr Foundation, Inc., 23 pp.
An experiment was conducted to assess the commercial feasibility of cage culture of channel catfish, and the report contains itemized data and discussion on production, biological and environmental factors, costs, and returns. Study objectives related to determination of fingerling size to reach food fish size in one growing season, stocking rate, suitability of two types of foods, and economic potential. Certain functional relations are reported, namely: profit increased with the size and rate of fingerlings stocked; total cost per pound of output decreased as stocking rate increased, as did average weight gain, although total weight gain decreased. Some comparisons and problems with commerical operations are discussed.
Subject descriptors:
Catfish; cage culture; method evaluation; revenue; costs; returns; experiment.

)26
)avis, James T.; Hughes, Janice S.
I970.
Channel catfish farming in Louisiana.
3aton Rouge, La. Wild Life Fish. Comm., Wildl. Educ. Bull. 98,
+8 pp.
Chis bulletin is intended as a practical guide to supply the)asic facts and principles necessary to start a commercial :atfish farm. Contents include location selection, pond :onstruction and techniques (fingerlings, spawning and hatching,)ond fertilizers, feeds and feeding, harvesting, holding, hauling ınd marketing). Costs of various items are mentioned, and one section includes an estimate of capital costs, and annual expenses and annual income on a per acre basis.
Subject descriptors:
Catfish; general description.

)27
)onahue, John R.
ı.d., circa 1967.
The United States catfish market.
J.S. Dep. Inter., Bur. Commer. Fish., processed, 11 pp.
Jatural catfish production and marketing problems are discussed, ınd the prospects for an expanded farm-cultured catfish market ıre suggested, if problems of erratic supplies, rising retail)rices, and inconsistent quality could be overcome. Several species of fish (freshwater, saltwater, and brackish water) of varying quality have been marketed as "catfish," with freshwater :hannel catfish generally being highest in quality and price. Markets have been mainly in producing areas, yet there is variation in product form, price, preferences, and price flexibility.
Subject descriptors:
Catfish; markets; marketing.

)28
Ford, Erwin C.
1969.
Potential of pond farm production.
Proceedings, Commercial Fish Farming Conference, Jan. 27-28, 1969, Athens, Ga., Univ. Ga., Coop. Ext. Serv. and Inst. Community Area Dev., pp. 77-78.
Factors to consider in evaluating the potential for catfish businesses and industry expansion are (1) the industry is new, with profits for entrepreneurial risk and with business failure expected for the same reasons as in other industries (inexperience and incompetence); (2) farm growth cannot be isolated from other functions, if consumption is to be increased; (3) quality of cultured fish must be maintained as a means of product identification (and separation from natural-stock catfish, which sells at lower prices); and (4) supplies must be adequate to satisfy

market demand through time and during the year.
Subject descriptors:
Catfish; problems; outlook.

029
Foster, Thomas H.; Waldrop, John E.
1972.
Cost-size relationships in the production of pond-raised catfish for food.
Miss. State Univ., Agri. Forestry Exp. Sta., Bull. 792, 69 pp.
Itemized costs and returns are provided for six farm situations, based on six sizes of ponds (5, 10, 20, 40, 80, and 160 acres) on 160 acres of land, and based on specified methodology, assumptions, and detailed supporting data. Input-output coefficients were synthesized on the basis of information from several sources, and factor prices were applied to estimate costs. Investment, cost, and return data are summarized in tables and one figure (which shows per-pound average total, operating and ownership costs as a function of pond size). Sensitivity analysis results indicate separately the effects of changes in fingerling and food costs on average cost of output, and of changes in output price on various measures of net income. Farm situation III (20-acre ponds) had the lowest average cost of output and highest net return, but no substantial net return differences occurred among farm situations III, IV, and V. The appendix provides detailed tables and discussion on input usage, labor time requirements, equipment and capital costs, pond design, and other variables.
Subject descriptors:
Catfish; revenue; costs; returns; economies of scale; sensitivity analysis.

030
Garner, Carroll R.; Halbrook, W. A.
1972.
Catfish production in Southeastern Arkansas: estimated investment requirements, costs and returns, for two sizes of farms.
Univ. Ark., Agri. Exp. Sta., Div. Agri., Rep. Ser. 203, 27 pp.
Estimates were made of investment costs, and annual costs and returns for a 40-acre farm with a 33-acre pond and a 160-acre farm with four 33-acre ponds. The data used were based on farm surveys, specified assumptions, and other information. Using itemized budgets, the costs and returns are compared for the two sizes of farms and economies of scale are shown. The effects of five price levels and six production levels are shown, demonstrating some aspects of risk.
Subject descriptors:
Catfish; revenue; costs; returns; economies of scale; sensitivity analysis.

031
Gray, D. LeRoy.
1970.
How to make a success in the fee fishing business.
Fish Farming Ind. 1(1): 28-31.
Growing demand for recreational fishing and prices in excess of those offered by processors are among the reasons a fish farmer may feel an initial interest in fee fishing operations. However, there are several factors necessary to a successful, profitable fee fishing business. Among these are location, customer amenities, aesthetic appearance, fishing quality, promotion (advertizing, contests, prizes), complementary goods and services, species mix, pond shape, pond size, stocking rates, and ability of the operator to handle certain problems. The operator must be able to meet customer demands. Liability insurance is a must. Labor may be a problem. Fish culture itself poses several problems. For reasons of fishing quality several species are suggested for consideration, with the selection depending on the local situation.
Subject descriptors:
Catfish; fee fishing; recreation; general description.

032
Greenfield, J. E.
1970.
Catfish marketing, 1970.
Catfish Farmer 2(3): 37-44.
Market functions, development, and problems are discussed. Marketing is the major barrier to continued, orderly growth of the catfish industry. Results of two surveys are reported briefly, one involving about 780 restaurants in the Midwest and South with respect to catfish, and the second involving some 1500 housewives who kept daily records of food purchases. Preliminary data for the second survey indicate income, racial, and regional characteristics for catfish consumers in 1969. In contrast, the restaurant survey indicated no significant seasonal, age, or racial patterns to catfish consumption in conventional, family-style restaurants. Restaurant managers' experience with catfish are among the other survey results discussed. Survey results and other information are related to market development and opportunities. Catfish supply factors are also discussed, for example, the declining importance of wild production, imports as a source of competition, the effects of possible changes in technology (such as the use of raceways or cages in place of ponds, or the use of powerplant thermal effluent), and large-market requirements of uniform high-quality, specification-complying product flows.
Subject descriptors:
Catfish; marketing; demand; consumption.

033
Greenfield, J. E.
1970.
Economic and business dimensions of the catfish farming industry (revised).
U. S. Bur. Commer. Fish., Ann Arbor, Mich., 38 pp.
Major headings include industry structure, production, processing, and marketing; the first two are emphasized. Discussed are production (farm) capital structure; operating performance (for three growing periods, 2 operations, average management); return on investment (ROI), sensitivity for the two operations for three "levels" of land value, growing period length, fingerling cost, harvesting cost and stocking rate; the effect of superior management; and the sensitivities of profit per acre and ROI to 11 output prices (24-44 cents per pound). Processing costs, industry value added, marketing, processing output and overall sales, and other aspects of the industry are discussed.
Subject descriptors:
Catfish; revenue; costs; returns; sensitivity analysis; processing; marketing; survey data.

034
Greenfield, J. E.
1970.
How much profit in pond culture?
Fish Farming Ind. 1(1): 32-35 and 44.
This article is based on Greenfield's report, Economic and business dimensions of the catfish farming industry, which is annotated separately.
Subject descriptors:
Catfish; revenue; costs; returns.

035
Greenfield, J. E.
1970.
1970 profile of the catfish market.
Fish Farming Ind. 1(2): 18, 19, and 25.
Marketing is a major problem facing the catfish industry for several reasons. Catfish is produced largely by crop farmers with little experience in specialized product markets and they don't understand marketing functions. Other reasons include demand and market character, difficulty in establishing brand preferences, and lack of preference for catfish as a species in regions of the country where per capita consumption of fish is highest. Results of two 1969 surveys financed by the Bureau of Commercial Fisheries are also reported briefly. One survey concerned 780 restaurant managers in the South and Midwest to determine their experience with catfish. The second survey concerned 1,500 housewives who kept daily diaries of food purchases; it showed per capita consumption of fish products by

income group, region and race, and data for catfish.
Subject descriptors:
Catfish; markets; marketing; survey data.

036
Greenfield, J. E.
1969.
Some economic characteristics of pond-raised catfish enterprises (revised).
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Econ. Mark. Res. Div., unpubl. manuscr., 19 pp.
Using information for the Mississippi Delta production region (Arkansas, Louisiana, and Mississippi), the author discusses capital costs, and how profits, costs and return on investment are sensitive to changes in the length of growing period, fingerling costs, harvesting costs, stocking rates, management level, prices, and selected combinations of these factors.
Subject descriptors:
Catfish; revenue; costs; returns; sensitivity analysis; processing; marketing.

037
Greenfield, J. E.
1969.
Some economic characteristics of pond-raised catfish enterprises.
Proceedings, Conference on Commercial Fish Farming, Jan. 28-29, 1969, Athens, Ga., Univ. Ga., Coop. Ext. Serv. and Inst. Community Area Dev., pp 67-76.
Using information for the Mississippi Delta production region (Arkansas, Louisiana and Mississippi), the author discusses capital costs, and how profits, costs and return on investment are sensitive to changes in length of growing period, fingerling costs, harvesting costs, stocking rates, management level, prices, and selected combinations of these factors.
Subject descriptors:
Catfish; revenue; costs; returns; sensitivity analysis; processing; marketing.

038
Grizzell, Roy A., Jr.
1972.
All you want to know about the fee fishing business "but were afraid to ask".
Fish Farming Ind. 3(3): 14-17.
Information is provided on U.S. catfish and trout fee fishing enterprises. Initial investment costs, and annual revenue, costs, and returns are itemized in a table for an 80-acre channel catfish fee fishing operation, with average net return to land and management of about $125 per acre. Growth in demand is

foreseen, but returns depend upon management ability. Several factors contributing to successful management are discussed. Among these are location, customer amenities (parking, picnic tables, restrooms, freedom from snakes and insects, etc.), fishing quality, advertising, geographic separation from fish farming activities that may be on the property, complementary goods and services (bait, snack, tackle, boat, and fish-cleaning facilities), charges (five are discussed), pond size, pond numbers, and proper fish culture techniques. Capital investment is in the range of several hundred thousand dollars for sophisticated operations.
Subject descriptors:
Catfish; trout; fee fishing; recreation; revenue; costs; returns.

039
Grizzel, Roy A., Jr.
1971.
SCS survey shows caged catfish culture not pie in the sky.
Fish Farming Ind. 2(3): 17-18.
The results of a 1970 Soil Conservation Service (SCS) survey of Arkansas operators of catfish cage-culture enterprises are reported, with data on the numbers of successes and failures, and a brief discussion of problems encountered in the initial commercial trials of this method. Of 586 cages, 55 were failures, 75 averaged 47% survival from fingerling to food fish size (i.e., 47% success), 39 had survival in the 80% to 100% range, and survival data on two large growers are not reported. The surveyed operators are optimistic about the future.
Subject descriptors:
Catfish; survey data; cage culture.

040
Grizzell, Roy A.; Sullivan, Edward G.; Dillon, Olan W.
1969.
Catfish farming, an agricultural enterprise.
U.S. Dep. Agri., Soil Conserv. Serv., Farm. Bull. 2244, 22 pp.
The report is a practical guide to successful catfish farming. The section on economics considers factors that affect the cost of capital and other inputs, market or product form choices, management decisions, and net returns. Other topics relate to water, pond structures, species selection, hatcheries, fingerlings, stocking procedures, feeding, winter care, troubles, treatments, and harvesting. Cost and input-use data are presented.
Subject descriptors:
Catfish; general description; costs.

041
Heffernan, Bernard E.
1974.
Five ways to cut costs on a catfish farm.
Fish Farming Ind. 5(1): 16-19.

Five of many cost-reducing changes in methods and equipment on the Edgar Farmer and Sons operation, Dumas, Ark., are discussed on the basis of an interview with Kelly Farmer, manager of the fish division. With the increase in feed prices, 800 instead of 2,000 1/2-pound catfish were stocked per acre of pond in 1973, along with 10 instead of 5 pounds of fathead minnows, and commercial feed was applied at the rate of 12 instead of 30 to 35 pounds per acre per day. Dust, which is undesirable for feeding, is recovered from feed at the rate of 1% to 3%. A refrigeration unit added to live-haul truck trailers reduced the requirements for ice from as much as 9,000 pounds to 500 pounds per trailer load (as much as 15,000 pounds of fish) on long trips. Lime is being added to ponds to reduce organic decay. Live-haul and seine harvesting equipment has been designed or improved, reducing labor requirements.

Subject descriptors:
Catfish; technology; techniques.

042
Jones, Walter G.
1969.
Market alternatives and opportunities for farm catfish.
Paper presented to the Fish Farming Conference., Oct. 1969, Texas A&M Univ., College Station, Tex. U.S. Bur. Commer. Fish., Ann Arbor, processed, 6 pp.

While the long-run prospects for catfish market development are viewed optimistically, growth requires planning and market research, and there are some short-run problems. The general market outlook is discussed, along with an indication of sources of competition for farm-raised catfish (wild U.S. and imported catfish, especially growth in the latter, and perhaps imported farm-raised catfish in the future). Price, quality, product form, and other differences exist; marketing research can help further identify avenues of development. Producer (farmer or grower) market alternatives include local, live-haul, processing plant, wholesaler and distributor, and fingerling and broodstock markets. Processor market alternatives include specialty restaurants, supermarket chains, food caterers, and foreign markets. Each of these alternatives is discussed as to current and future importance.

Subject descriptors:
Catfish; markets; marketing.

043
Jones, Walter G.
1969.
Market prospects for farm catfish production.
Proceedings, Conference on Commercial Fish Farming, Jan. 27-28, 1969, Athens, Ga. Univ. Ga., Coop. Ext. Serv. and Inst. Community Area Dev., pp. 49-61.
In assessing future prospects, quality, production, market, and demand factors are discussed with emphasis on the latter. U.S. per capita and total fish consumption, and import growth are cited as factors affecting the demand for farm-raised catfish. Using estimated or actual data for 1955-68, wild and farm-raised production, imports and total U.S. catfish supplies are projected for 1969-75 at two levels. The data are shown in tables and graphs, along with prices for wild catfish from several States or producing areas. The projections were made informally (without a formal mathematical model) on the basis of the author's 10-year association with the industry. He indicated that rapid growth in imports, wild-cultured fish price differentials, lack of market development (promotion), and other factors could affect potential sales expansion in the Midwest and other areas outside the main producing region.
Subject descriptors:
Catfish; production data; import data; consumption data; forecasts; marketing; markets; outlook.

044
Kinnear, H. M.
1972.
Catfish spawning--trough culture makes a big difference.
Amer. Fish Farmer World Aquacult. News 3(6): 6-7.
The shift from the use of natural to controlled environment catfish spawning at the Leon Hill Catfish Hatchery, near Lonoke, Ark., is described briefly on the basis of an interview. Hill estimates that with natural spawning in outdoor ponds about 15% of the eggs become fingerlings, and that there is about 50% survival under controlled conditions. Careful supervision, water temperature control (80 degrees F., plus or minus less than 1 degree), water quality control, proper feeds, feeding, and other aspects of procedure are discussed. The business is said to be profitable, but subject to risk.
Subject descriptors:
Catfish; technology; hatcheries; techniques.

045
Kirby, Martin.
1972.
Catfish vs. poverty?
Amer. Fish Farmer World Aquacult. News 4(1): 8-9.
A plan devised by Earl Evans, an Arkansas catfish farmer, aimed at fighting poverty in Arkansas and Mississippi is outlined. It

would require $2.6 million for implementation in 10 Arkansas counties and $2.6 million in 15 Mississippi counties, most of which would come from the Office of Economic Opportunity and the Economic Development Administration. Participants in these programs would receive technical, managerial, and biological aid in the establishment of catfish farms. The projection of new catfish farmers was estimated at 150 with about 6,000 more acres of catfish farms in each of the two States.
Subject descriptors:
Catfish; economic development role.

046
Lee, Jasper S.
1971.
Catfish farming, a reference unit.
Miss. State Univ., Curriculum Coord. Unit Vocat. Tech. Educ., 103 pp.
While this "publication is designed primarily for use by secondary teachers of agricultural occupations," it is a useful, descriptive, nontechnical handbook in which chapter 1 (job 1) provides an economic view and prospectus of the catfish farming business and industry. Besides this, topics include pond and other water facility construction, fingerling production, growing food, feeding, water management, disease and parasite control, other controls (predators, trash fish, and other pests), harvesting and hauling, marketing, processing, and bibliography. Also presented are revenues, costs and returns for selected scales of operation (different pond acreages and output levels); equipment costs, equipment lives and minimum-maximum compatible acreage levels; investment (initial) costs; projected total and per capita consumption (to year 2020); marketing alternatives; and other factors that affect business and industry performance.
Subject descriptors:
Catfish; general description; revenue; costs, returns; consumption data; forecasts; markets.

047
Lee, Jasper S.
1973.
Commercial catfish farming.
Interstate Printers and Publishers, Danville, Ill., 263 pp.
The material in this book covers a broad range of factors which influence the catfish industry. The first three chapters include the history of catfish farming and how to establish a catfish farm. The biology of catfish, the construction of water facilities, and securing and managing water are described in three chapters. There are chapters on nutrition of catfish, production and selection of breedfish and fingerlings, increasing growth, harvesting, and marketing. Other chapters cover controlling diseases, parasites, predators, and other pests. There is a chapter on recreational fee-lake operation. The final

chapter describes the methods and forms of catfish processing. In one appendix a chart relates length to weight per thousand fish, number of fish per pound, and weight of each fish. Another appendix gives catfish recipes.
Subject descriptors:
Catfish; technology; methods; marketing; general description.

048
McCoy, E. W.; Ruzic, J. E.
1973.
Alabama's recreational catfish ponds.
Auburn Univ., Agri. Exp. Sta., Bull. 451, 21 pp.
The objectives of the study were to determine the supply of Alabama recreational catfish water, related demand factors, problems encountered in production and marketing, and fishout operation characteristics. A complete inventory of these operations was made in 1971. Percentage distribution data are given for operator age, occupation, size of operation, location, government assistance, feed source, and other variables. Financing, equipment, marketing procedures and problems, and expansion plans are discussed, as well as reasons for poor returns, factors affecting demand (population of surrounding area, location with respect to population centers and highways, size of ponds, harvest per pond and/or stock rate, price, concessions, and facilities), and demand relationships.
Subject descriptors:
Catfish; recreation; fee fishing; recreation demand.

049
McCoy, E. W.; Sherling, A. B.
1973.
Economic analysis of the catfish processing industry.
Auburn Univ., Agri. Exp. Sta., Circ. 207, 20 pp.
On the basis of information obtained in a 1971 survey of 19 of 21 Southeastern United States catfish processing plants, and specified assumptions, the authors estimate that the industry operated at 36% of capacity in 1970. Anticipated raw material purchases for 1971 would have allowed operation at 59% of capacity, but actual purchases fell short. The problems are rapid industry growth, and extreme seasonality of production (summer raw material shortage). Cost, employment, and other information are provided. Itemized costs for producing a pound of output total 80 cents (1971) for a hypothetical plant operating at 36% of capacity, and 66 cents, at 100% of capacity. Alternatives for improvement are analysed.
Subject descriptors:
Catfish; processing; revenue; costs; returns.

050
McCoy, E. W.; Ruzic, J. E.
1973.
Raise catfish for fun and profit--or neither.
Auburn Univ., Agri. Exp. Sta., Highlights Agri. Res., 20(1): 8.
With growing demand for recreation and the remoteness of many previously used sites from urban population centers, special complexes and facilities are being built, including public fishout ponds. Ponds with catfish increased from 50 in 1965 to 700 in 1970 in Alabama, meaning a shift to catfish, since bass and bream were once the leading kinds of fish stocked. Net return to land, labor and management is higher for the ponds fished for a short while, after which they are drained and the remaining fish are commercially harvested. Where recreational fishout is the only harvesting device, this net return is lower per acre. It is higher per pound harvested, but fewer pounds are harvested. Other factors affecting profits and losses, and operator satisfaction are discussed.
Subject descriptors:
Catfish; recreation; fee fishing; revenue; costs; returns.

051
Madewell, Carl E.
1971.
Economic and related considerations before entering or expanding a commercial catfish or trout farming operation.
Paper presented to Fish Farming Conference, Nov. 4, 1971, Montgomery Bell State Park, Burns, Tenn. T.V.A., 20 pp.
Pre-investment considerations, and some production and marketing challenges are discussed. The former include legal, environmental, technical, marketing, financial, assistance sources, management, and economic factors. An expanding market is foreseen, for which trout and catfish both have suitable characteristics, but some processing problems existed in 1970 (location, seasonally excess capacity and other problems). Initial investment, annual costs and returns, and net return may be compared economically with similar measures for other farm enterprises; such data are shown for catfish ponds, and catfish and trout raceways. Comparisons for a limited number of Alabama producers indicate that net returns to land, labor, and management for catfish equal or exceed returns for peanuts, cotton, and soybeans (Yeager, 1971). Improvements in technology, efficiency, product, and competitive ability are among the industry challenges, as suggested in part by a comparison of farmer-to-consumer prices and expenses for catfish, trout, and pork.
Subject descriptors:
Catfish; trout; revenue; costs; returns; forecasts; outlook.

052
Madewell, Carl E.
1973.
Economics of catfish raceway production.
Paper presented at Fish Farming Conference sponsored by Tenn. Fish Producers Assoc., Dec. 5-6, 1973, Montgomery Bell State Park, Burns, Tenn. T.V.A., 11 pp.
Demand, market, supply, processing, and production (farm) information and data from several sources are summarized and updated (to 1973). The outlook for expansion of catfish production appears good, because it offers several advantages to farmers, processors, distributors, and consumers. While per capita consumption (edible weight basis) is estimated as about 1 pound in the Tennessee Valley region, another estimate (Cordouk, 1970) is that U.S. per capita consumption of catfish may reach 7 pounds by 1990. Processing costs are indicated along with the effect of operation at 36% of capacity (after McCoy and Sherling, 1973, using 1970 data), since below-capacity operation is still a problem, although the number of plants has declined (21 in 1971 and 10 in 1973) and output has increased. Prices and expenses from farmer to consumer are compared for catfish and pork. Catfish and catfish-trout raceway investment costs, annual costs, and annual returns are itemized based on preliminary data provided by Georgia researchers.
Subject descriptors:
Catfish; trout; production data; forecasts; revenue; costs; returns; consumption data; processing; method comparison.

053
Madewell, Carl E.; Ballew, Ralph J.
1972.
Historical development of catfish farming.
Amer. Fish Farmer World Aquacult. News 3(3): 8-11.
This article presents a brief history of how fish farming began and expanded in the United States, with particular emphasis on catfish farming. The Saltonstall-Kennedy Act for commercial fisheries in the 1950's triggered an increased interest in R&D in fish culture among colleges and fish culture labs. Intensive catfish farming began in the 1960's. Acreage increased from 400 in 1960 to 45,000 in 1970 while average yield per acre increased from 800 pounds in 1960 to 1,200 pounds in 1970. The projection for 1975 is that there will be 75,000 acres of food fish and yields of 1,500 pounds per acre. The value of catfish at the farm level soared from $150,000 in 1960 to $19 million in 1970. Some problems which the catfish farming industry must overcome are listed. They include: (a) decreasing high production costs, (b) improving quality and making a variety of catfish products available to consumers on a year-round basis, and (c) improving production efficiency.
Subject descriptors:
Catfish; history; technology; methods; problems; outlook; costs.

054
Madewell, Carl E.; Carroll, Billy B.
1969.
Intensive catfish production and marketing.
T.V.A., Rep. F69ACD6, 30 pp.
This report summarizes available literature on industry growth, nature of the catfish farm enterprise, current production, and marketing; interprets the meaning of this information so far as a potential Tennessee Valley industry is concerned; and suggests possible approaches for industry development. Literature for 1961-68 is cited. While the U.S. catfish industry is in its infancy, specialization is beginning to occur among farmers, economies of scale and complexities are evident, and returns to land and management may equal those for any other farm enterprise, although these returns are quite variable among operators. Factors that make farm-raised catfish a new product are discussed. Marketing channels, expected market growth, market development needs, and approaches to industry development are considered in the remainder of the report. Appendix tables contain 1947-67 Tennessee Valley fish production data; forecasts of channel catfish market, production, acreage, and output per acre to year 2020 (after Mitchell and Usry, 1967); and seven budget statements for different kinds of catfish operation (after Grizzell, 1967).
Subject descriptors:
Catfish; production data; forecasts; marketing; revenue; costs; returns; technology.

055
Mange, Frank A.; Thompson, Russell G.
1969.
An application of an investment model to channel catfish farming.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Econ. Mark. Res. Div., unpubl. manuscr., 40 pp.
The purpose of the model is to identify some important aspects that should influence investment decisions in channel catfish farming enterprises. The results exhibit a number of economic relations of which the following were most important: (1) When initial average profits were 20 cents per pound and the initial price of land, buildings, and equipment was close to $800 per acre, the initial investment policy of the firm was one of continuous purchase of new capacity. (2) Higher initial average profits resulted in larger maximum capacities up to a limiting size, beyond which further increases in profits resulted in increases in net worth, but not in capacity. (3) The investment policy of the firm was found to be very sensitive to initial prices of capacity higher than $800 per unit, and no new capacity was added if prices of capacity reached $1,500 per acre. (4) Profit accumulation and, thus, investment decisions were found to be sensitive to changes in the interest rate paid for financing new capacity. (Authors' abstract.)
Subject descriptors:
Catfish; investment model.

056
Meyer, Fred P.; Sneed, Kermit E.; Eschmeyer, Paul T.
1973.
Second report to fish farmers (the status of warmwater fish farming and progress in fish farming research).
U.S. Dep. Inter., Bur. Sport Fish. Wildl., Resource Publ. 113, 123 pp.
This is a practical handbook. Several business and industry practices and choices are discussed in terms of their economic impact, sometimes in terms of cost or revenue. Topics include: culture methods, feeding and feeds, diseases, pond management, harvesting, marketing and processing, high-density culture methods, stock improvement, mixed species culture, noncatfish species culture (golden shiner, fathead minnow, goldfish, buffalofish, crayfish, and bass, black, white and striped), and fish and arable land crop rotation. Per-acre gross and net returns (to land, management, and risk) are shown for various alternative land and fish crops (1970 data). Investment (initial) cost and operating costs and returns are shown for a business with two 10-acre ponds (1970 data).
Subject descriptors:
Catfish; general description; revenue; costs; returns.

057
Miller, Morton M.; Nash, Darrel A.
1969.
The development of catfish as a farm crop and an estimation of its economic adaptability to radiation processing.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Econ. Mark. Res. Div., unpubl. manuscr., 136 pp.
Economic activity relating to wild and farmed catfish is described so far as possible with available, often insufficient secondary data through about 1966-67. Costs and returns for harvesting wild stocks, farming, processing, marketing, and distribution are discussed and shown in tables, along with price, consumption, market, seasonality, estimated price elasticity, and other information. Market output is then projected for the period 1975-85; the benefits and costs of fresh, radiation-pasteurized, and frozen catfish products are compared; and it is concluded that the radiation-pasteurized form would provide considerable economic benefits over the alternatives, given the assumptions and methodology used in quantification.
Subject descriptors:
Catfish; production data; consumption data; marketing; processing; demand analysis; forecasts; benefits; technology; radiation processing.

058
Mullins, Troy.
1970.
Capital requirements for initiating a catfish production enterprise.
Amer. Fish Farmer 1(3): 12-14.
This article relays the results of a 1966 study on the capital requirements for starting a catfish farm. A sample of 28 farmers reported their acreage, their choice of having growth ponds or growing fingerlings, costs of construction of service buildings and reservoirs, harvesting costs, costs of water supply, and feeding costs. Several tables report the number of reservoirs and approximate investment (averaging $399 per acre). Also reported are the increase in fish farm acreage (from 1,600 in 1963 to 29,000 in 1969) and the decrease in construction costs in 1968 and 1969.
Subject descriptors:
Catfish; survey data; costs; investment.

059
Nelson, Roy.
1972.
The marketing point of view: processing or pay lakes?
Catfish Farmer 4(2): 13-14.
Potential marketable output has been estimated as 200 million pounds of catfish (live weight). While the largest part now moves through the fee ponds, a declining percentage of output is being sold in this market (87% in 1969 and 67% in 1971, with 50% estimated for 1973). The lower priced processing market is judged to be more stable and continuing, but growers must be able to satisfy requirements, such as large enough quantities on a consistent basis with a seasonal flow pattern that would allow processing plant operation at steadier rate of output throughout the year.
Subject descriptors:
Catfish; markets; marketing; industry development; outlook.

060
Nichols, John P.; Lacewell, Ronald P.
1971.
A marketing system: the step beyond production.
Amer. Fish Farmer World Aquacult. News 2(5): 18-20.
The functions and importance of the marketing system are discussed briefly. Some of the present problems of the catfish industry are due to the nonperformance of some of these functions. To achieve increased output, producers will have to understand what is being communicated about consumer tastes and preferences by the marketing system, for example preferences for quality, convenience, and dependable supplies. Research can help solve marketing problems.
Subject descriptors:
Catfish; marketing.

061
Pippin, Kenneth; Morrison, W. R.
1975.
Retail market potential for farm-cultured catfish.
Univ. Ark., Agri. Exp. Sta., Bull. 799, 22 pp.
Results of a 1973 survey (Little Rock, Ark.) to evaluate the market potential and consumer preferences for farm-cultured catfish are reported. Potential is expressed in terms of sales (pounds purchased) per thousand supermarket patrons. Preferences are related to socioeconomic characteristics. Chi square analysis was employed. Purchases tended to increase with household income, homemaker education, and occupational status of the head of household; purchases tended to decrease, but less clearly, with family size and with the presence of younger members. Other results are indicated.
Subject descriptors:
Catfish; markets; demand; consumption; evaluation.

062
Raulerson, Richard C.; Trotter, Warren K.
1973.
Demand for farm-raised channel catfish in supermarkets: analysis of a selected market.
U.S. Dep. Agri., Econ. Res. Serv., Mark. Res. Rep. 993, 21 pp.
In March and April 1972, a controlled Latin square market experiment was performed in six Atlanta grocery stores to determine the demand for fresh channel catfish in supermarkets. Prices ranging from $0.79 to $1.29 per pound in 10-cent increments were used to elicit quantity responses. These responses were used to estimate linear, log-linear, and log-log forms of a demand curve. The resulting demand curves indicate an elastic demand for catfish within the experimental price range. Results of a consumer questionnaire indicate the possibility of expanding the market by introducing more convenient product forms at a reasonable cost to the consumer. (Modified authors' abstract.)
Subject descriptors:
Catfish; demand analysis.

063
Rogers, Bruce D.; Madewell, Carl E.
1971.
Catfish farming--cost of producing in the Tennessee Valley region.
T.V.A., Natl. Fert. Dev. Cent., Circ. Z-22, 20 pp.
This report indicates estimated catfish production in the Tennessee Valley for alternative operations. Costs are based on interviews, estimates, and specified assumptions. The operations are compared with respect to key variables in one summary table. Initial cost, and annual costs and returns are itemized in 17 appendix tables. The summary table indicates for 17 operations

the acreage, capital cost per firm and per acre, price received, profit (return to management) per acre and as a percentage of initial investment, and production cost per pound of catfish or fingerling. Eight pond, two fingerling, three fishout, and four raceway operations are compared. A case example of poor management is analysed. An appendix contains questions for a potential catfish farmer to ask in evaluating the situation.
Subject descriptors:
Catfish; revenue; costs; returns; enterprise comparison.

064
Russell, Jesse R.
1972.
Catfish processing--a rising southern industry.
U.S. Dep. Agri., Econ. Res. Serv., Agri. Econ. Rep. 224, 33 pp.
This report describes the catfish processing industry in nine southern states in 1970, and attempts to determine factors affecting the economic operation of the 16 plants surveyed. The infant industry--only 3 of the 16 processors marketed any fish before 1968--is still experimenting with different methods of processing and marketing. Processing methods include hand labor, machine use, and a combination of both. Obtaining a steady supply of fish--especially in slack summer months--to increase the utilization of capacity is the major problem facing the industry. In contrast to a total capacity of 21.3 million pounds (live weight), the plants processed only 6.4 million pounds in 1970. This study was made in response to both the rapid growth of catfish farming and the importance of processing in developing markets for increased production.
Subject descriptors:
Catfish; processing; methods; problems.

065
Sullivan, Edward G.
1970.
The role of the Soil Conservation Service in the catfish industry in Mississippi.
Catfish Farmer 2(3): 25-26.
Since the Soil Conservation Service (SCS), an agency of the U.S. Department of Agriculture, views catfish farming as a farm (agricultural) enterprise, it provides technical assistance in site selection, and in pond and water system lay out. It works through county offices and Soil Conservation Districts, which usually coincide with counties geographically. SCS made a special survey of catfish farming in Mississippi in spring 1969. Of 11,648 acres in commercial production, SCS has provided complete engineering design on 7,259 acres and technical advice and guidance on another 3,988 acres. While some large farms are in a position to hire their own engineers for design work, SCS will continue to provide soil interpretations and soil maps.
Subject descriptors:
Catfish; government assistance; survey data.

066
Yeager, J. H.
1971.
Factors determine the suitability of catfish farming (to be or not to be a fish farmer).
Amer. Fish Farmer World Aquacult. News 2(12): 19-21.
Several aspects of fish farming are reviewed for the prospective aquaculturist. The prospective fish farmer will want to consider legal, technical, financial, economic, and managerial aspects of growing catfish before beginning an operation. Revenue, cost, and return information is itemized briefly for 58 Alabama catfish producers categorized into small, medium, and large pond operations. (See abstract under J. L. Adrian and E. W. McCoy for more details.)
Subject descriptors:
Catfish; revenue; costs; returns; survey data; prospectus factors.

TROUT

067
Anonymous.
1972.
Bob Erkins talks trout marketing.
Fish Farming Ind. 3(2,3, and 5): 20-24; 31, 32, and 34; and 30.
An interview with Robert A. Erkin, operator of the 1000 Springs Trout Farm, Inc., Buhl, Idaho, concerning markets and marketing is provided in three parts using questions and answers. The trout market is somewhat concentrated in northern States with people who are fish eaters by experience, it is restaurant (gourmet item) centered, it does not have ethnic patterns, and it has become less seasonal than in the past with year-round production and freezing. The product is sold in 8-, 10-, or 12-ounce drawn form (gilled and eviscerated, but with head, fins, and tail intact). Shelf life, freezing techniques, and packaging are discussed. In contrast to most of the past 20 years, the last 2 years have brought a sellers' market because Danish and Japanese products virtually disappeared from the market. Accurate production data are not available, but the 1971 market is estimated to have been about 6 million pounds of processed, farm-raised rainbow trout, including 1.5 million pounds of imports, and excluding live trout sold for private and public stocking. Estimates for 1972 are 9.4 million pounds, including 2.5 million pounds of imports. Estimates for 1973 are 11.8 million pounds, including 4.0 million pounds of imports. Output is limited by market (demand) rather than by production (supply). Output could be increased 25% without depressing price, if promotion began 12 to 14 months in advance. Promotion is by product, rather than by firm or brand. In terms of a 10-year

market outlook, Erkins indicates that (1) product competition comes from fish in general, (2) fish market expansion is on the basis of population rather than per-capita-consumption growth, but population growth rates have slowed, (3) fish prices have advanced considerably in the past 10 years, but this is not true for catfish and trout, and (4) with a good marketing program, output of processed trout could reach 25 million pounds by 1980.
Subject descriptors:
Trout; markets; marketing.

068
Anonymous.
1972.
Georgia researchers look at trout-catfish rotation.
Fish Farming Ind. 3(5): 12-13.
Information is given on a study by E. Evan Brown, T. K. Hill, and J. L. Chesness on trout only in South Georgia where winter temperatures are usually suitable for trout, and where summer weather is suitable for catfish growth, allowing the possibility of two crops. Weather records suggest fewer than 120 days with water temperatures below the critical 70 degrees F., and the winter, 1971-72, growing effort lasted 105 days. Initial cost, annual cost, annual return, computational assumption, feed conversion, production method, average and actual market price (involving fishout lake, processor, and local markets) data are provided.
Subject descriptors:
Trout; markets; techniques; revenue; costs; returns; biology; survey data.

069
Anonymous.
1973.
Pointers to consider when planning to farm trout.
Fish Farming Internatl. 1 (1): 92-94.
The growth of trout farming in Northern Ireland (1968-73) is discussed, along with information from an advisory leaflet for prospective farmers (The development feasibility and economics of rainbow trout farming in Northern Ireland, by Stuart Fidgeon). Land area, water requirements, construction and operating costs, prices and returns are estimated for farm units of 25, 100, and 150 ton capacity. Feed, fry, labor, and other costs are indicated. The trout are assumed to reach 6 to 8 ounce marketable size 16 months from fry stage.
Subject descriptors:
Trout; costs; returns; marketing; Ireland.

070
Araji, A. A.
1972.
An economic analysis of the Idaho rainbow trout industry.
Univ. Idaho, Coll. For., Wildl. Range Sci., Dep. Agri. Econ., AE Series No. 118, 9 pp.
This preliminary report describes the current status of the industry in terms of its economic and business dimensions, including per capita consumption, production, processing, demand, and marketing. Major headings include: cost structure of the Idaho trout industry, demand potential, production, and marketing problems. Revenue, cost, return, and value added analysis for trout production, processing and marketing, and Idaho agricultural receipts from farm marketing are illustrated and discussed.
Subject descriptors:
Trout; demand; marketing; revenue; costs; returns; value added; problems.

071
Arroyo, Igor Solar.
1973.
Chile develops the cultivation of trout in cages.
Fish Farming Internatl. 1(1): 99-104.
An account is given of aquacultural developments in Chile since 1968, when the Fish and Game Division of the Agriculture and Livestock Service began experiments. Details of rearing experiments are given, including trout cage construction, feeding, economics and output levels. Estimated initial costs, and annual revenue, costs and returns for a 70-cage operation are itemized. Less detailed data are shown in a comparison of operations with 30, 50, 70 and 100 cages.
Subject descriptors:
Trout; Chile; revenue; costs; general description.

072
Berge, Leidolv; Farstad, Nelvin.
1971.
Norwegian pondfish farming.
Paper presented at Internatl. Symposium on Fisheries Economics, Paris, Nov. 29-Dec. 3, 1971. O.E.C.D., FI/T(71)1//25, 29 pp.
This is a condensed version of a longer, Norwegian-language report. Based on 1966 and 1970 survey information, the Norwegian pondfish industry is described and analysed in economic terms to explain variations in profits and costs. The output, mainly rainbow trout, increased from 200 metric tons in 1962 to 1,000 metric tons in 1969. Variable, fixed, and total costs for some of the 260 firms are shown and discussed along with other data to show variation in labor and capital costs per kilogram of output. Investment, stocking, feed, and other cost items are discussed. Small firms (10 to 15 metric tons per year of output) provide

supplementary part-time income. Larger firms can consider natural resource and market points in location. Output range is about 1 to 70 metric tons per firm. Feed consists mainly of waste and small fish, some of which is operator caught, with conversion at 6 to 7 kg per kilogram of fish produced. Very little dry feed is used; future feed may include krill. Marketing problems relate to the competitive nature of the firms, product competition with salmon and sea trout, luxury-fish price (about three times cod prices), inability of many producers to hold ("store") live fish past Christmas, quality variations, and other factors.
Subject descriptors:
Trout; Norway; revenue; costs; returns; production data.

073
Brown, E. Evan; Hill, T. K.; Chesness, J. I.
1972.
Rainbow trout--a new money crop for South Georgia.
Univ. Ga., Ga. Agri. Res., Fall, 1972, pp. 10-12.
Problems, a trial operation, itemized initial costs and annual costs and returns, computational assumptions, and other information are given relative to the growth of rainbow trout in a new eight-segment raceway on University property at Tifton, Ga. The trout were stocked on December 10, 1971. Data for the previous year indicate that one might expect less than 120 days with temperatures below the critical 70 degrees F., and 6- to 8-inch fingerlings were stocked to reach 10- to 12-ounce market size in this time. Harvest occurred after 105 days. Sales were made locally, to fishout ponds, and to a fish processor, with the price averaging $0.664/lb. Even counting an unexplained (one-night) loss that caused most of the 17 percent mortality, feed conversion was quite good (1.3 lb commercial, floating, dry feed per 1.0 lb of fish, live weight basis).
Subject descriptors:
Trout; revenue; costs; returns; raceways.

074
Collins, Richard A.
1972.
Cage culture of trout in warmwater lakes.
Amer. Fish Farmer World Aquacult. News 3 (7): 4-7.
The results of a study are reported briefly, along with methods, materials, and technical details. Inspection of surface water temperature of lakes indicates that southern Arkansas, northeast Texas and central parts of Mississippi, Alabama, and Georgia should provide about a 150-day winter growing season, during which time 3-ounce trout may grow to 12 ounces. The following data are provided for a nine-cage, 115-day experiment: stocking rate, mortality, number harvested, average and total weight, total weight gained, and feed conversion rates. Information is also given on fingerling, feed, cage, and labor costs, revenue, and computational assumptions.

Subject descriptors:
Trout; experiment; method evaluation.

075
Gooby, Dick.
1971.
Idaho trout farmer profits on 10-cent margin.
Fish Farming Ind. 2 (3): 36-38.
Large firms grow, process, and market trout, but it has not been feasible for them to develop small springs. One way for these large firms to increase output to the rate necessary for profitable operation has been to provide fingerlings to land holders with smaller springs and to offer compensation for grow-out services at a specified rate, 10 cents per pound of trout in this case. The firm's 1970 output was 70,000 pounds, and two or three crops may be put through the grow-out process in a year, with stocking at 4 to 5 inches and selling at about 12 inches. The 1970 gross was $7,000; feeding labor, $1,080; pond amortization, $700; and total annual costs, $1,780. The net return exceeded that for an 80-animal beef cattle operation, for which similar revenue and cost data are indicated.
Subject descriptors:
Trout; revenue; costs; returns; enterprise comparison.

076
Klontz, George W.
1973.
A survey of fish health management in Idaho.
Univ. Idaho, For., Wildl., Range Exp. Stn., Info. Ser. 3, 34 pp.
The text and some of the tables of this report are published in Amer. Fishes U.S. Trout News 18(9): 8, 9, 11-13, 16, 17 and 20. To better understand fish health problems, Federal, State, and commercial fish-raising systems were surveyed in Idaho in 1973, and resulting 1972 production, costs, employment, and other information are reported. The commercial production of trout, salmon, and catfish has several component operations. Rainbow trout output totaled 27.4 million pounds in 1972, compared to 0.75 million pounds in 1956; catfish output was 0.1 million pounds in 1972; and output of both is expanding, judging by information for 1973. Mortality rates and costs for eggs and fish (three sizes of fish, 1 to 3, 3 to 6, and 6 to 12 inches long) are detailed, and consequent losses are estimated for private growers only. While mortality rates decline with age (e.g., eggs, 16.5%; 6- to 12-inch fish, 6.4%), mortality among 6- to 12-inch fish accounts for 75% of the loss, because production cost is higher for the older fish. Production costs for purposes of loss estimation include feed, labor, and egg costs, but not capital outlay, return on investment, and other components of gross revenue; losses totaled $0.56 million out of production costs of $7.95 million.

Subject descriptors:
Trout; production data; revenue; costs; biology; general description.

077
McGuinness, Fred.
1973.
Prairie pot hole trout: hard way to make a buck.
Fish Farming Ind. 4(2): 22-26.
Grow-out of trout from fingerling to market size in Canadian Prairie Province pot holes has become an income-supplementing enterprise for about 1,500 operators, mostly grain and cattle farmers. The pot holes generally range in size from 1 to 20 acres, and there is a wide range in productivity owing primarily to differences in water quality and natural food supplies (freshwater shrimp). Some data on fingerlings, permits, harvest, and yield are provided individually for the provinces. Total catch was estimated at 0.4 million pounds in 1972. Harvest is by gill net and boat in October or by gill net through the ice in December. A 1970 experiment by the Fisheries Research Board of Canada involved stocking 18 pot holes, which averaged 16.3 acres in size (293.4 acres total), and a 39.1% average recovery (range 0% to 70%) in the 23,000-pound harvest (78.4 pounds per acre, average). Marketing restraints were removed in 1972 because of adverse effects on the industry, and a processing breakthrough appears to have occurred in 1973.
Subject descriptors:
Trout; development; general description.

078
Meade, James W.
1971.
A reference list for trout culturists, revised December 1971.
Penn. Fish Comm., Div. Fish., Benner Spring Fish Res. Stn. (R. D. No. 1, Box 200-C, Bellefonte, Pa., 16823), unpubl., 5 pp.
This reference list provides the names, authors, and publishers of books, periodicals, booklets, pamphlets, articles in publications, and addresses of other sources of information about trout and other fish culture.
Subject descriptors:
Trout; technology; bibliography.

079
Mull, Wilbur C.; Fair, Armor John.
1970.
Selected aspects of the market demand for rainbow trout in Atlanta and Northeast Georgia.
Univ. Ga., Coll. Bus. Adm., 9 pp.
This report summarizes the results of an initial local market

survey based on information from 20 agencies and firms. Retail stores and restaurants are the primary consumer outlets. The market is supplied by rainbow trout from Georgia and nearby States, Idaho, and other countries. A frozen product is generally preferred. Large retail chains are primarily interested in attractive packaging, uniform quality and cost. Rainbow trout is served in the more exclusive restaurants where it appeals to a limited clientele; its bones and price appear to limit consumption on a mass-market basis. Georgia producers might be able to increase sales by promotion to differentiate their product, by making the product more competitive in price in retail chain stores, and by supplying the larger national market. The results are limited to the area and by the absence of secondary data on national and regional markets.
Subject descriptors:
Trout; markets; survey data.

080
Pritchard, G. I.
1973.
Fish farm projects in Canada.
Fish Farming Ind. 1(1): 112-114.
Canada has some 300 private trout hatcheries, mostly small firms. The growing use of fingerlings relates to planting in lakes, streams and pot-holes, again mostly by small firms. Some salmonids are grown near larger cities. There has been a resurgence of oyster culture, along with research into the culture possibilities for other species, and the development of more supportive attitudes and economic conditions. Yet, the industry is still viewed as having high risks, high development costs, low market concentration (mainly small firms), local market penetration, low profits and a low degree of vertical integration.
Subject descriptors:
Canada; trout; oysters.

081
Scott, Clyde A.; Fessler, Floyd R.
1970.
There's profit in trout production.
Fish Farming Ind. 1(3): 18, 21 and 22.
Based on a 1969 Soil Conservation Service (SCS) survey of 286 private trout growers in 16 States and on other information, several topics are briefly discussed, notably water use, marketing, raceway design, feeding, stocking, and costs and returns. Nonthermal springs are the major source of water which must range from 45 to 70 degrees F., and preferably 55 to 64 degrees. Groundwater temperature is about the same as mean annual air temperature. A flow of 1 cfs can support annual output of 10,000 to 14,000 pounds of trout. Information is given on raceway design and preferences by region, feeding (dry feeds,

uses of automatic and hand feeding), and two kinds of fishout ponds. An itemized cost-return table shows initial costs, annual costs and returns, and computational assumptions for a synthesized operation producing 26,000 pounds of trout annually.
Subject descriptors:
Trout; survey data; marketing; raceways; revenue; costs; returns; biology; fee fishing.

SALMON

082
Anonymous.
1975.
Salmon farming: an emerging industry.
Commercial Fish Farmer Aquacult. News 2 (1): 6-20.
Factors, firms, agencies, people and problems involved in the emergence of this industry are discussed. NMFS conducted initial net-pen experiments in 1969, and the rapid expansion of the industry is indicated by the increase in output between the 1973-74 and 1974-75 seasons, from 350 to 740 metric tons, including output from ocean ranching as well as net pens. Factors and problems of importance include institutional and legal constraints for both methods, site selection, feed costs and availability, technique improvements (to reduce costs), and commercial feasibility. It may be 3 to 5 years before economic feasibility can be determined, owing to uncertainty about market demand for pan-sized salmon, prices, and costs.
Subject descriptors:
Salmon; outloook; general description.

083
Anonymous.
1972.
To market, to market, to buy a small salmon.
Pac. NW SEA 5(1): 3-8 and 12-13.
A pilot salmon aquaculture project conducted by Ocean Systems, Inc. (OSI) and funded partially by Sea Grant is discussed. The project was categorized into four phases: (1) incubation, (2) freshwater cultivation, (3) saltwater cultivation, and (4) test marketing and analysis. Problems in the incubation stage include faulty fertilization, siltation due to heavy rains, low water temperatures, and a fungus. In the freshwater cultivation stage, the food conversion rate is discussed as is Sea Grant's $100,000 matching funds-type grant. Water temperatures, current flow, and storm protection are among the main items discussed in the saltwater cultivation stage. Losses were also caused by dogfish sharks chewing holes in the pens and consuming the salmon and by birds scooping out some fish. In a sample of 27 brokers,

wholesalers, etc., taken in July 1970, in 9 major cities, the National Marine Fisheries Service found that verbal commitments were made for about 300,000 pounds of the cultivated salmon.
Subject descriptors:
Salmon; biology; cage culture; experiment; hatcheries; markets; survey data.

084
Bollman, Frank Herbert.
1971.
River basin development and the management of anadromous fisheries: an economic analysis of the Columbia River experience.
Ph. D. thesis, Univ. Calif. (Berkeley), Dep. Agri. Econ., 793 pp.
Large main-stream dams have affected the habitat for anadromous fish runs in the Columbia River, which accounts for 40% of the U.S. hydroelectric power potential and 25% of the salmon and steelhead catch in the Northwest. This study focuses on an evaluation of the costs and benefits of mitigation programs (fish passageways and hatcheries) and on the institutional setting for these programs. Capital outlay, annual costs of operation and maintenance, costs of biological research and investigation and public and private power company costs are estimated for 1939-69 and for future continuation of the programs. Benefits and costs are compared. Methodology problems for sport fishery evaluation are reviewed, and future demands for sport fishing are estimated. With respect to institutions, an analysis is made of tenure status of the resource, conceptual validity and operational usefulness of limited entry, legal and social institutional fish protection, and the effectiveness of State fishery regulations.
Subject descriptors:
Salmon; hatcheries; benefit-cost analysis; method evaluation; demand analysis; government assistance; production data; recreation demand; investment model.

085
Fraser, Jim; Martin, Stephen G.
1972.
The economic and biological feasibility study of rearing chinook salmon, chum salmon and Pacific oysters at the Squaxin Island, Port Gamble and Skokomish reservations.
Federal Way, Wash., Small Indian Tribes Org. W. Wash., Inc., Final Report, 60 pp. (Obtain from NTIS, COM-73-10110.)
The techniques are described for experimentally growing chinook and chum salmon in nylon webbed pens. Results at Squaxin Island indicate that chinook salmon did well, but chum salmon suffered high mortality in the summer. Preliminary data suggest that Squaxin Island and Port Gamble may be able to support commercial raft culture of Pacific oysters, and that this may be quite profitable, but further investigation is suggested for all three reservation sites. The authors warn that member tribes lack

business experience and may consequently face crop failures in aquaculture. (Based on NTIS abstract.)
Subject descriptors:
Salmon; oysters; biological feasibility; experiment; economic feasibility; problems; techiques; returns.

086
Gates, J. M.; Mueller, J. J.
1975.
Optimizing the growth and marketing of fish in a controlled environment.
Mar. Tech. Soc. J. 9 (5): 13-16.
An optimizing model is presented for salmonid aquaculture, although it is adaptable to any species of interest. It is illustrated using hypothetical data; it can be solved using any standard linear programming algorithm. Physical plant and related fixed costs are assumed, so that the optimization decisions relate to operating costs (which are functionally dependent on biomass and temperature regimes) and revenues. Fish size at time of sale and seasonal phasing of marketing are considered.
Subject descriptors:
Salmon; systems analysis.

087
Joyner, Timothy; Mahnken, Conrad V. W.; Clark, Robert C., Jr.
1974.
Salmon--future harvest from the Antarctic Ocean?
Mar. Fish. Rev. 36 (5): 20-28.
Salmon has been chosen as the most likely candidate for the introduction of fish farming in the Antarctic Ocean. Scientists are anxious to introduce fish farming into the Antarctic region primarily because of the high potential of using krill, a small shrimplike crustacean, as food for the translocated fish. The natural abundance of krill in the Antarctic Ocean would provide food for the salmon and thus reduce production costs for the farming operation. The authors discuss the oceanography of the Antarctic, wind patterns, and probability of adaptation of each salmon species to the Antarctic climate. Several maps and tables are also presented.
Subject descriptors:
Salmon; Antarctic Ocean; techniques; oceanography; biology.

088
Koposov, A. F.
1964.
Some problems concerning the efficiency and economics of artificial rearing of salmon in the Sakhalins (Nekotorye Voprosy effektivnosti i ekonomiki iskusstvennogo razvedeniya lososei na Sakhaline.)

Lososevoe Khozyaistvo Dal'nego Vostoka, E. N. Pavlovskii et al, editors, pp. 179-183. (Copy of translation available on loan from NMFS).
Problems concerning economies of scale and location of hatcheries in the Sakhalins are discussed. The size of the hatchery is limited by the availability of spawners and the water supply. An example is given involving the construction of 13 small hatcheries with a total capacity of 111 million eggs. To put most of the hatcheries into operation, roads, river crossings, and settlements with the necessities of life had to be constructed at a cost of about 20 million rubles.
Subject descriptors:
Salmon; hatcheries; economies of scale; location factors.

089
MacDonald, C. R.; Meade, T. L.; Gates, J. M.
1975
A production cost analysis of closed system culture of salmonids.
Univ. R. I. Mar. Tech. Rep. 41, 11 pp.
This report considers systems design and operation, production processes, and costs for a model commercial salmon culturing operation with the capacity to produce about 1 million smolts at a cost of about 10 cents each, or $0.97 to $1.07 per pound. Two culture systems are involved, one for egg hatching and the growth of fingerlings, and the other for growth of fingerlings to smolts. The production cycle lasts 270 days. Costs, input usage and factor prices are carefully detailed and itemized in tables to allow updating and application to other circumstances.
Subject descriptors:
Salmon; closed system culture; costs.

090
Mahnken, Conrad V. M.; Novotny, Anthony J.; Joyner, Timothy.
1970.
Salmon mariculture potential assessed.
Amer. Fish Farmer World Aquacult. News 2(1): 12-15, and 27.
The authors discuss environment and facilities of the NMFS Aquacultural Experiment Station, Manchester, Wash., experimental stocks, feeding schedules, growth measurement, diseases and predators, and possible problems. Puget Sound tidal currents provide an almost continuous flow of water through floating enclosures, allowing a loading density of 1 pound of fish per cubic foot of water. One year of encouraging experimental work with this system and the years of work in developing a successful freshwater salmon hatchery system "provide the basis for an optimistic outlook for the future development of intensive, egg-to-market culture of Pacific salmon." Technical problems are indicated and judged solvable. The institutional problem of a prospective salmon farmer's acquiring land and water use rights is viewed as a possible barrier, unless zoning authorities accept

floating systems of fish culture as an appropriate use of inshore marine waters.
Subject descriptors:
Salmon; cage culture; general description; legal barriers.

091
Novotny, Anthony J.; Mahnken, Conrad V. W.
1971.
Farming Pacific salmon in the sea: from the "womb to the tomb."
Fish Farming Ind. 2(5): 6-9; 3(1): 19-21.
The authors report various aspects of a 2-year biological study on growing salmon in enclosed mesh cages, and indicate that the system should prove to be commercially feasible. Topics include the environment, feeds and feeding, fish transfer from freshwater to saltwater and related variations among species as to acclimation requirements, genetics and breeding work, survival rates in the system developed, diseases, and floating pen design (both nursery and growing pens). The purposes of the study were to determine coho salmon growth rates using specific dietary conditions and to determine problems with the system described. The study was made at the NMFS marine research station, Manchester, Wash.
Subject descriptors:
Salmon; cage culture; biology; experiment; biological feasibility.

092
Richards, Jack A.
1968.
An economic evaluation of Columbia River anadromous fish programs.
Ph. D. thesis, Oreg. State Univ., 274 pp.
Columbia River irrigation, flood control, navigation, and recreation are important, often complementary products with hydroelectric power, but dam and reservoir construction blocks the migration of the anadromous fish. Costs of passage way, hatchery, and related mitigating items are developed and discussed in this thesis. Owing to the lack of appropriate market prices as a basis of valuation, benefits of commercial (including Indian) and sport fishing are estimated according to specified methodology. Benefits and costs of the programs are compared. Benefits for commercially caught fish are estimated on the basis of the cost of regulated inefficiency. Benefits for sport caught fish are estimated using transfer costs as proxies. Conclusions are made concerning the economic justification of the program in the 1930's and in 1965.
Subject descriptors:
Salmon; hatcheries; benefit-cost analysis; method evaluation; production data; demand analysis; costs; government assistance; recreation demand; investment model.

093
Richards, Jack A.; Mahnken, Conrad V. M.; Tanonaka, George K.
1972.
Evaluation of the commercial feasibility of salmon aquaculture in Puget Sound.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., N.W. Fish. Cent., unpubl. prelim. analysis, 35 pp.
Topics include descriptions of biological and ecological systems, and analyses of production costs, marketing, and cost and returns for a salmon aquaculture operation the size and structure of Ocean Systems, Inc. (now Domsea) activity, which is based on R&D work by NMFS and partial funding by Sea Grant. Capital equipment initial costs, estimated lives, and amortized annual amounts are shown, along with operation and maintenance costs (for labor, eggs, utilities, maintenance, heated water, leasing, and permits), and finally total annual costs, by function (incubation, pond rearing, and pen rearing, then total) and cost item. Uncertainty ("risk") returns necessary to encourage investment are discussed as to causes, results, effects of reduction, and relation to limitations and restrictions of entry into aquaculture. Assuming the market would support prices sufficient to cover the opportunity costs of resources used, plus an initial return for risk, preliminary analysis suggests that salmon aquaculture is economically feasible, but there are some serious information gaps.
Subject descriptors:
Salmon; costs; returns; marketing; risks; investment model.

094
Roberts, Kenneth J.
1972.
Economics of hatchery salmon disposal in Oregon.
Oreg. State Univ., Mar. Advisory Progr., Sea Grant 17, 20 pp.
The sale of salmon returned to hatcheries as opposed to the sale of commercial salmon in Oregon is discussed. The Fish Commission of Oregon (FCO) set up a grading system in 1971 to judge the quality of returned hatchery salmon. A grade of 1 is given those fish returned in good condition. No restrictions are put on their use. Grade 2 means that fish could be used for any purpose other than in the fresh or fresh frozen market. Grade 3 indicates that the fish is in poor condition and may be used for nonhuman consumption only. Hatchery sales from 1968 to 1971 were between 4.7% and 6.5% of commercial landings. A tabled comparison is given of utilization of surplus coho and chinook (as fresh market, canned, smoked or kippered, animal food, crab bait, rendered, or dumped). More salmon was used in the fresh market in 1970 (36%), but that figure declined to 19% in 1971. Oregon is a surplus producer of seafood. Data on markets are given for FCO hatchery sold salmon (1968-71) in Oregon, Washington, California, other States, and other countries. The conclusions include (1) due to the FCO grading system, the sale of poor quality returned salmon for human consumption has

decreased, (2) salmon sold from hatcheries have had only a minimal effect on the prices of commercial salmon because poundage of hatchery salmon used for human consumption has been less than 5% of commercial landings, and (3) the effect that the sale of poor quality salmon has on the fresh market has been eliminated.
Subject descriptors:
Salmon; hatcheries; markets.

095
Stevens, Joe B.; Mattox, Bruce W.
1973.
Augmentation of salmon stocks through artificial propagation: methods and implications.
Adam A. Sokoloski, editor, Ocean fishery management: discussions and research. U.S. Dep. Commer., Natl. Mar. Fish. Serv., NOAA Tech. Rep. Circ. 371, pp. 133-145.
The Pacific Coast has 81 hatcheries that rear significant numbers of salmon and steelhead for sport and commercial fisheries. Annual operation and maintenance costs are $6.6 million. A production function analysis of 15 Oregon Fish Commission hatcheries led to tentative conclusions that (1) controlled inputs were combined in fixed proportions, (2) constant returns to size were realized, and (3) some degree of factor substitution existed between the controlled "fixed proportion input" and water temperature. The latter relationship may allow hatchery managers to improve efficiency at the hatchery level. Uncertainty about the downstream environment, however, must be considered along with returns to scale for the hatchery production function when new investments are undertaken. Fixed asset theory was used to conceptualize exit and entry of salmon-harvesting resources between 1947 and 1966. Net entry followed years of good catches, but net exit did not occur following the bad years. If a major objective of hatchery programs is to augment fishermen's incomes, consideration must be given to increasing the opportunity costs of extant resources as well as to limiting entry of new resources. (Modified authors' abstract).
Subject descriptors:
Salmon; hatcheries; costs; returns; economies of scale.

096
Wagner, Louis C.
1973.
An evaluation of the market for pan-sized salmon.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Market Res. Serv. Div., Res. Contract Rep. N208-0344-72N, 50 pp.
During mid-1972 the first cultured, pan-sized salmon were test marketed in several U.S. cities, mostly on the West Coast. Information was gathered on market acceptance via interviews of brokers, wholesalers, and restaurateurs. Reactions are summarized by product characteristics and by market area. The

producing units (Domsea, Lummi Indian Tribes, and Small Indian Tribes), methods, estimated harvest, and factors affecting market potential are also discussed. Restaurant reactions concerned ways of preparing, menu description, relative price, lunch vs. supper offerings, packaging, quality, size, color, boned vs. unboned forms, and popularity. Over two-thirds of the restaurants charged more for pan-sized salmon than other varieties of fish on the menu, but the product is discussed in terms of competition primarily with trout and fresh or frozen salmon items from larger fish. The pan-sized salmon was dressed, heads-on, eviscerated, glazed, and sized (6-8, 8-10, 10-12, or 12-14 ounces) by the producer (Domsea).
Subject descriptors:
Salmon; market; marketing.

097
Wahle, Roy J; Vreeland, Robert R.; Lander, Robert H.
1974.
Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific salmon fisheries.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Fishery Bull. 72(1): 139-169.
Marked coho salmon, Oncorhynchus kisutch, smolts of the 1965 and 1966 broods were released from 20 hatcheries on four sections of the Columbia River and tributaries. Commercial and sport fisheries in marine waters from Pelican, Alaska, to Avila Beach, Calif., and on the Columbia River were sampled during 1967-69 for marks. The net value of the estimated total catch of hatchery fish was calculated after adjusting for the effects of marking. Also estimated for each brood were the total costs of rearing including amortized capital outlay. Total benefits of $8.58 million for the 1965 brood and $9.11 million for the 1966 brood were estimated as applicable to normal production years when no marking takes place. Corresponding costs were estimated as $1.29 million for the 1965 brood and $1.23 million for the 1966 brood. Estimated benefit/cost ratios for the 20 Columbia River coho salmon hatcheries, as operated under production regimes prevailing during the study, may prove useful in decisions affecting management policies. The ratios are 6.6/1 for the 1965 brood, 7.4/1 for the 1966 brood, and 7.0/1 for both broods combined. (Authors' abstract.)
Subject descriptors:
Salmon; hatcheries; benefit-cost analysis.

OYSTERS AND OTHER MOLLUSKS

098
Agnello, Richard J.; Donnelley, Lawrence P.
1975.
The interaction of economic, biological, and legal forces in the Middle Atlantic oyster industry.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., Fishery Bull. 73(2): 256-261.
Economic, environmental, and legal forces are contributing factors in the decline of the Middle Atlantic oyster industry. This paper determines the interactions and importance of these forces by quantifying and integrating some of the relevant variables into a supply and demand model of the oyster industry. The statistical results yield significant and expected parameter values with useful information on price and income demand elasticities. Also implications of common property legal frameworks on resource utilization are revealed. The main conclusions are that efforts to rehabilitate the industry by cleaning up pollution, replacing cultch, and encouraging legal private property rights may have large social values. (Authors' abstract.)
Subject descriptors:
Oysters; supply; demand analysis; model.

099
Castagna, Mike.
1972.
Economic potential of clam operation and economic survey of scallop operation.
Va. Inst. Mar. Sci., unpubl. prelim. rep., 16 pp.
Preliminary information is provided on an experimental VIMS operation at Watchapreague, Va. Estimated capital costs, borrowing requirements, and 10-year flows of operating costs, revenues and cash are detailed. Some suggestions for reducing costs and improving profit performance are made. [For discussion of the biology, cultural techniques employed, and some aspects of the bay scallop's economic suitability for culture, see Michael Castagna, 1975, Culture of the bay scallop, Argopecten irradians, in Virginia. Mar. Fish. Rev. 37(1): 19-24.]
Subject descriptors:
Clams; scallops; costs; revenue; returns.

100
Cavanagh, Carroll.
1974.
Luck, management, laws result in Connecticut oyster 'boomlet'.
Natl. Fisherman, 54(12): 4-C.
For the first time in decades, a boat began buying oyster seed in the narrow lower estuary of the Housatonic River. The seed were harvested by boats with small hand-haul dredges. Outside of the

mouth of the river lies the virtually unused, but historically important, public-ground Bridgeport Natural Bed (4,800 acres). Laws, changed to allow dredging instead of hand tonging (1968); shell spreading, lifting, and desilting; predator control in the seeding area; grower association expansion; leasing of recently unused grounds; widespread and intense spat set in summer 1973 and other factors suggest a possible industry regrowth. Some data are given on such items as catch, yield, and spat-per bushel.
Subject descriptors:
Oysters; problems; general description; legal barriers.

101
Charbonneau, Joseph John.
1974.
A spatial analysis of selected impacts on the South Atlantic oyster processing industry.
Ph.D. Thesis, Univ. Md., 92 pp.
While the "primary objective of this study is to determine the regional impacts of a shift in the processing cost structure" associated with both pollution abatement and introduction of an automatic shucking machine, some of the results may be of use in evaluations of oyster aquaculture. A simultaneous equations approach was used to estimate supply and demand functions. Income elasticities of demand were in the range -0.297 to +0.389, and were based upon three procedures and 1969 cross-section household survey data for nine regions of the country.
Subject descriptors:
Oysters; supply; demand analysis; model.

102
Costello, Frederick A.; Marsh, Brent L.
1972.
Systems engineering of oyster production.
Univ. Del., Coll. Mar. Studies, Dep. Mech. Aero. Eng., Pub. no. 2EN066, Sea Grant GH-109, Rep. no. DEL-SG-5-72, 55 pp.
An interim report describing briefly some aspects of the methodological approach used to optimize a system with stochastic properties, unknown distribution functions, large numbers of variables and equations, and other problems. The application discussed is to algae production which is a subsystem process that is part of the larger system, production of oysters in a closed environment. Algae production costs for a cost-optimized American Cyanamid originated process are shown; they form the baseline for sensitivity analysis. The results of the sensitivity analysis that are shown are based on changing certain stochastic variables 10% and 20% from their nominal values. Those variables requiring further study are identified in terms of their frequency-distribution deviation values (investment o initial cost deviation values and amortized annual equivalent cost deviation values). The discussion is technical in setting

and 45 of the 55 pages of the report contain computer program listings and printouts, but the report does not contain a program documentation (flow diagrams, user guides, term definitions, etc.).
Subject descriptors:
Oysters; closed system culture; systems analysis; sensitivity analysis; costs; experiment.

103
Gibson, Gary G.; Lund, Dennis S.
1973.
A pilot economic study of oyster raft culture in Yaquina Bay, Oregon.
Abstract only is in Proc. Natl. Shellfish Assoc. Convention, 1972, vol. 73, p. 7. (Authors are with Fish Comm. Oreg. and Newport Oyster Co., Newport, Oreg.)
Based on recorded costs for a single raft (12 ft by 20 ft), adjustment of capital costs for larger scale operation (addition of costs for concrete anchors, piling, boom logs and harvesting equipment), and adjustment in the number of 6 ft strings of suspended Japanese oyster seed, gross revenue of $3.33, costs of $1.37 and net return of $1.96 per string were estimated. A price of $20 per bu (in-shell, cocktail-sized oysters, 100 meats per pint) and 206 strings per raft were assumed.
Subject descriptors:
Oysters; revenue; costs; returns; raft culture.

104
Gunter, Gordon; Demoran, William J.
1971.
Mississippi oyster culture.
Amer. Fish Farmer World Aquacult. News 2(5): 8-12.
Oyster species, behavior, feeding, shell deposits, commercial production, human food nutritional qualities, and cultural methods are described. Leased beds are employed in Virginia and Louisiana, but not Mississippi and Texas, for example. An agency of Mississippi State can open and close oyster reefs, plant shells or seed, move oysters for purposes of depurification, and administer culling and harvest restrictions. The agency is credited with a fivefold increase in oyster output in 20 years, but its efforts are limited by funding, which is dependent on a severance tax. Data for 1960 to 1970 are given on amounts of shell and seed planted, and oysters moved for depurification.
Subject descriptors:
Oysters; government assistance; public grounds; industry development.

105
Hidu, Herbert.
1969.
The feasibility of oyster hatcheries in the Delaware-Chesapeake Bay region.
Kent S. Price, Jr., and Don L. Maurer, editors, Proceedings, Conference on Artificial Propagation of Commercially Valuable Shellfish, Oysters, Oct. 22-23, 1969, Univ. Del., Coll. Mar. Studies, pp. 111-131.
Feasibility is examined from the biological, economic, and socio-political viewpoints. The emphasis is on research progress on the biological systems in a hatchery (conditioning and spawning, larval rearing, and spat rearing) and on experimental progress on biological hatchery production costs. Some paradoxes are raised. The region provides an excellent growth medium, but natural seed has sometimes not been fully utilized. Private growers and public-agency buyers who were questioned indicated unwillingness to pay more than the price of natural seed, with some oyster grounds going unworked for lack of seed. Since the estimated cost of hatchery seed is 3 to 7 times the price of natural seed, hope for its use is seen only via further research and experimental work to reduce production costs. Socio-political factors affecting possible use of hatchery seed are discussed briefly.
Subject descriptors:
Oysters; hatcheries; R&D role; problems.

106
MacKenzie, Clyde L., Jr.
1970.
Oyster culture modernization in Long Island Sound.
Amer. Fish Farmer World Aquacult. News 1(6): 7-10.
Increased oyster seed productivity in Long Island Sound is discussed. This is the result of improved equipment, control of major causes of mortality, better preparation of oyster-setting beds, and production of oyster seed from hatcheries. Techniques of seeding beds, controlling predators (common starfish and boring snail), and controlling suffocation by silt are explained Yields obtained by oyster companies today have increased from about 1 to 10 or more bushels of oysters from 1 bushel of young seed oysters. Greater production of better quality oysters is forecasted.
Subject Descriptors:
Oysters; ground culture; biology; general description; government assistance.

107
MacKenzie, Clyde L., Jr.
1970.
Oyster culture in Long Island Sound, 1966-1969.
Commer. Fish. Rev. 32(1): 27-40.
Topics discussed include oyster culture practices, problems, BCF (now NMFS) activity, practice-improving effects on yield, seeding, equipment and other factor-use, and some cost information. Seed shortages were traced to lack of property (lease) rights on public beds and to improper seed bed preparation on private (leased) beds. Predators must be removed, and clean shell spread only when larvae abundance is high. Cultural practices for growth from seed to market size include predator and competitor removal, seed planting, annual thinning and transplanting (3-4 times), and harvesting (4- to 5-year old oysters, at which time costs are estimated at $2.50 per bushel, including $1.25 for culling). Equipment and improvements, causes of oyster mortality, and remaining problems (i.e., as determined in the BCF project, but requiring further work to solve) are discussed.
Subject descriptors:
Oysters; problems; biology; private grounds; government assistance; costs.

108
Marsh, B. L.; Morrison, A. W.; Costello, F. A.
1972.
Systems engineering of oyster production.
Univ. Del., Mech. Aero. Eng. Dep., Sea Grant 2-35223, 21 pp.
Results of systems engineering analysis are discussed in terms of cost reduction effects for a synthetic closed-environment oyster culture system originally designed by American Cyanamid (1968). Given certain assumptions (e.g., 15-year, 8% amortization; 100,000-bushel annual output; 70 degrees F. water temperature), costs are itemized. Per bushel costs are estimated as: $64, without water recycling; $49, with 85% recycling; $22, with an optimized system and available technology; and as low as $13, with a modest research program, a cost said to be competitive with costs of cultured, natural environment oysters for the half-shell trade. Specified research projects are evaluated in terms of expected return (cost reduction multiplied by probability of project success).
Subject descriptors:
Oysters; closed system culture; systems analysis; R&D role; costs.

109
Marsh, Brent Luther.
1973.
Techniques for design of large-scale systems.
Ph. D. thesis, Univ. Del., Dep. Mech. Aero. Eng, 223 pp.
The primary concern is the presentation of methods developed to optimize large systems with stochastic properties, to select from among the many large-system variables the ones requiring design work and optimization, and to do this selection using computer language notation. Application is to a hypothetical, closed-environment oyster production system with output of 100,000 bushels annually, and average cost is reduced from about $49 to $22 per bushel. Three kinds of uncertainty are considered, namely in design variables, parameters, and functional relationships. Sensitivity analysis is used to isolate aspects of the system requiring design work, given some reasonable base design, and the least sensitive variables or aspects of the system are then "fixed," allowing design work to be concentrated on the smaller "dominant problem" (p. 90). The often obscure nature of computer-language equations is overcome by the use of a print-out matrix (rows represent equations; columns, variables).
Subject descriptors:
Oysters; closed system culture; systems analysis; costs.

110
Mason, J.
1972.
Mollusc culture in Scotland.
World Fish. 21 (9): 42-44.
Extensive beds of oysters once existed in Scottish waters, but they have diminished for several reasons. Because of market demand, new methods are being developed to culture both oysters and mussels. Rather than the native oyster Ostrea edulis, Crassotrea gigas is being emphasized, with output of 1 million seed oysters per month. Cultural techniques have been adapted from those used in other countries for mussels, and the difficulty of rearing natural larvae means that dependence is placed on natural spat fall. (Based on ASFA abstract.)
Subject descriptors:
Scotland; oysters; mussels; general description.

111
Matthiessen, George C.
1970.
A review of oyster culture and the oyster industry in North America.
Woods Hole Oceanogr. Inst., Contrib. No. 2528, 52 pp.
The conclusion section reviews several factors which account for past and prospective progressive development of oyster culture. The report has sections on eight geographical areas of the North American continent. Each section discusses species grown,

production practices, oyster ground control and rights (public vs. private grounds), prices, problems, economic incentives, industry organization, research, government involvement and assistance, and the use or potential use of certain cultural methods (e.g., hatcheries, raft culture, pond culture, selective breeding, and closed-environment culture). The factors accounting for progressive development are high market demand, legislation favorable to leasing of oyster grounds, willingness and ability to invest in research, and maintenance of water quality favorable to oyster culture.
Subject descriptors:
Oysters; biology; R&D role markets; demand; legal barriers; development; general description.

112
Matthiessen, G. C.; Toner, R. C.
1966.
Possible methods of improving the shellfish industry of Martha's Vineyard, Duke's County, Massachusetts.
Edgartown, Mass., Mar. Res. Found., 138 pp. (Obtain from NTIS, PB 173 095.)
While not the primary focus of this report, the last part of the report (pp. 110-131) includes recommendations, estimated capital and operating costs for an oyster hatchery, other cost information, computational and other assumptions, institutional and other constraints affecting the potential expansion of the Duke's County mollusk industry, and an effort to assess return on investment for an oyster hatchery.
Subject descriptors:
Mollusks; oysters; bay scallops; hard clams (quahog clams); soft shell clam; biology; hatcheries; biological feasibility; experiment; development rationale; institutions; constraints; method comparison; costs.

113
Menzel, Winston.
1971.
The mariculture potential of clam farming.
Amer. Fish Farmer World Aquacult. News 2 (8): 8-14.
Quahog clam (genus Mercenaria) behavior, biology, suitability for culture, problems, experimental results and recommendations are discussed. While predators and labor costs, especially in the nursery or hatchery stage, pose problems, estimated gross revenue would seem to suggest as good a return as for other animal species being considered for culture, judging by preliminary experimental data.
Subject descriptors:
Clams; biology; experiment; outlook.

114
Morse, N. H.
1971.
An economic study of the oyster fishery of the Maritime Provinces.
Fish. Res. Board Can., Bull. 175, 81 pp.

The fishery is characterized by low productivity, low investment per firm (low capital to labor ratio), slow adoption of mechanized harvesting technology and certain other problems, but the most critical problem relates to the economic provision and use of seed oysters, such as via hatcheries. The industry's development and institutional setting is analyzed. Policy options appear to lie between "support of numerous small oyster producers and opening the oyster areas to the highest bidders who probably would develop the largest and strongest industry with the minimum of public assistance." Some cost estimates are presented. Based upon a 1966 survey, output (both market and seed oysters), number of enterprises, number of leasehold enterprises, investment, net income and other information is provided. While there is some analysis of supply and demand, lack "of adequate quantitative data has made it impossible to arrive at answers to many relevant questions."

Subject descriptors:
Oysters; Canada; costs; survey data.

115
Pesson, L. L.
1974.
The coastal fisherman of Louisiana: their characteristics, attitudes, practices, and responsiveness to change.
LSU, Cent. Agri. Sci. Rural Dev., Coop. Ext. Serv., Sea Grant 04-3-1518-19, 60 pp.

There were 16 oyster farmers in the stratified random sample of 500 (7% sample) Louisiana coastal parish fishermen. The 467 usable schedules were obtained in August 1972 to April 1973. The report's eight sections deal with respondent characteristics; fishing operations; opinions, attitudes, and problems; knowledge of and contact with Cooperative Extension; usage, opinion, and source of new ideas; leadership and participation patterns; shrimping practices, and other fishing practices. By comparison, oysterers have large operations (p. 54). Sample percentage distribution data are given for method (75%, dredges), type and size of boat, number of crew, acreage cultivated (under 200 acres, 38%; 200-400 acres, 24%; over 400 acres, 38%), acreage planted in past year, problems, harvest last year, and time commitment (73%, part-time). Generally, coastal fishermen tend to be middle-aged, have a low level of education, live in a rural area, value self-reliance, and have a pattern of change indicating normal adoptive behavior.

Subject descriptors:
Oysters; socio-economic data; survey data; techniques.

116
Quayle, D. B.
1969.
Pacific oyster culture in British Columbia.
Fish. Res. Board Can., Bull. 169, 192 pp.

While the primary concerns of this report relate to the biology and cultural techniques for oysters, information of interest in economic evaluations is included, such as historical quantity and value data (oysters, from 1884; Pacific oysters and seed imports, for more recent years only), estimated ground (1969) and raft (1953) culture costs, and a discussion of marketing, products, processing and institutional factors. Problems include pollution and growth-related encroachments into traditional (more productive) grounds.

Subject descriptors:
Biology; general description; costs; problems.

117
Rockwood, Charles E.
1973.
A management program for the oyster resource in Apalachicola Bay, Florida.
Fla. State Univ., Tallahassee, Fla., 350 pp.

This report recommends a management program for the oyster resource in Apalachicola Bay to improve efficiency, enhance the oyster output potential, and improve marketing for the product. Franklin County (which borders on the Bay) is profiled as to social and economic indicators of its economic growth or nongrowth. The scope and size of the oyster industry is also discussed. Several tables of employment and oyster data are presented. Price data, demand, supply, investment, and value added in the oyster industry are discussed. Conclusions as to the status of these factors in the economic development of Franklin County are made.

Subject descriptors:
Oyster; costs; demand analysis; marketing; methods.

118
Shaw, William N.
1971.
Oyster culture research--off-bottom growing techniques.
Amer. Fish Farmer World Aquacult. News 2 (9): 16-19 and 21.

An off-bottom oyster culture project undertaken by the Natl. Mar. Fish. Serv. in 1968, is discussed. Three methods (longline, rigid structure, and raft) were tested. In November, 1969, growth and meat quality were compared for the three methods. Very little difference was found. The two largest companies using off-bottom methods are in California. They produce about 30,000 gallons of oyster meats annually.

Subject descriptors:
Oysters; method comparison; general description.

119
Tarr, Marvin A.; Carr, Mark I; Westley, Ronald E.
1971.
Biological evaluation of floating oyster culture (Section B), and Economic evaluation of the floating oyster culture (Section C) of final report of investigations for the Lummi Aquaculture Project.
Wash. State Dep. Fish., Manage. Res. Div., 20 pp.
Biology: Using facilities of the Western Oyster Company, floating and bottom culture methods were compared during the period November 1970 to September 1971. Study methodology, limitations, and results are given. Raft culture was found superior to ground culture, except for fouling.

Economics: Raft culture costs (for Western Oyster Company) are compared to bottom culture costs for Puget Sound, Grays Harbor, and Willapa Bay for 1971 (questionnaires and interviews, data for 50% of Washington Pacific oyster, Crassostrea gigas, production). Raft-cultured oysters were harvested after 1 year on the raft (16-20 per half pint), and ground-culture oysters, at 3 years (medium oysters, 8-10 per pint). Costs per gallon of oyster meat for the two methods are itemized to include seed, planting and culture, and harvesting.
Subject descriptors:
Oysters; raft culture; ground culture; method comparison; costs; returns; survey data; biology.

120
Vaughn, Charles L.
1973.
National survey of the oyster industry's problems.
Natl. Mar. Fish. Serv., Market Res. Serv. Div., Contract Rep. N-043-41-72, 92 pp.
Based upon NMFS processing-firm population data, oyster processing firms were stratified on the basis of location (East, Gulf, and Pacific Coasts) and dollar volume of oyster product sales (less than $0.1, $0.1 to 0.5 and over $0.5, in millions) in 1970. Of 523 firms, 192 were sampled. The 1972-73 survey employed mail questionnaires and nonrespondent interviews. It was intended to ascertain and rank specific industry problems. The survey results are summarized in discussion and detailed tables. Topics include: attitude about future business prospects, problems, market outlets, capital expenditure plans, role of the Shellfish Institute of North America, product forms, areas of the business with greatest future, and employment. The tables employ frequency distributions, U.S., by size of firm and by region. The firms buy oysters, shuck, and sell oyster products, mostly fresh. Sales concentration is apparent. Supply problems, relating to pollution mainly, and production problems, relating especially to shortages of qualifed labor, are among the leading difficulties. Aquaculture of seed and market-size (processor-input size) oysters ranks fairly low among "aspects of the oyster business with greatest future," and "finished

convenience items" leads, followed by the shelling and shucking of oysters (raw). The survey results differ somewhat by size of firm and by region.
Subject descriptors:
Oysters; survey data; markets; prospectus factors; problems.

SHRIMP AND OTHER CRUSTACEANS

121
Anderson, Lee G.; Tabb, Durban C.
1971.
Some economic aspects of pink shrimp farming in Florida.
Proc., Gulf Caribb. Fish. Inst., 23d Annu. Sess., Nov. 11, 1970, pp. 113-124.
Using estimated cost data, specified assumptions, three sizes of farms (100, 500, and 1000 acres), two kinds of output (bait and food shrimp), six prices of land ($250 to $15,000 per acre) and other information, the authors compute and show internal rates of return (IRR), along with tables of net cash flows (and computational components, namely capital and operating costs with some detail, and gross revenue) for 16-year hypothetical operating periods. Economies of scale are apparent. Labor is a significant cost. Only two of the six operations proved profitable, given the land prices and crop prices assumed. With higher food shrimp prices (72 cents per pound assumed for 36-count shrimp) the situation might be less pessimistic. However, increasing the number of crops from one to three (110-count instead of 36-count shrimp) did not improve profits. Market price effects are discussed and would be significant for a large (1,000-acre) bait-shrimp farm. [Annotator's note: for partially revised investment data, see Lee G. Anderson, 1973, An economist looks at mariculture, ..., Mar. Tech. Soc. J. 7(3): 9-15.]
Subject descriptors:
Shrimp; investment model; economic feasibility; revenue; costs; returns; sensitivity analysis; demand analysis; markets; outlook.

122
Anonymous.
1972.
Marifarms Incorporated.
Estabrook and Co., Faherty and Swartwood Inc., 40 pp.
This prospectus contains information typically provided to investors and stockholders, such as descriptions, operations, balance sheet, income statement, risk factors, and information on stocks, and legal and other matters. "The Company is developing the business at its facilities located on 2,500 acres of bay near Panama City, Florida. The business consists of the location and

collection of gravid mother shrimp, the hatching of young shrimp from eggs spawned by the mother shrimp (using Japanese-derived hatching techniques), the cultivation of the hatched shrimp in open water through the Company's proprietary technology and the harvesting and sale of the cultivated shrimp."
Subject descriptors:
Shrimp; investment; techniques; R&D role; markets; outlook; general description; financing.

123
Avault, James W., Jr.
1972.
Crayfish farming in the United States.
Paper presented at the First International Symposium or Freshwater Crayfish, Sept. 12 to 15, 1972, Hinterthal, Salzburger Land, Austria. La. State Univ., Cent. Wetland Resour., Sea Grant Preprint No. 897, 23 pp.
Topics include species, biology, farming, and other items. The industry is primarily centered in Louisiana, with live-weight output of over 10 million pounds annually, valued at $5 million. Until recently this came mostly from wild stocks. Rice-fiel ponds, wooded ponds, and open ponds are used in farming, an cultural practices are essentially similar. The crop is harvested about 1 year after the brood fish are stocked, and lift nets and funnel traps of chicken wire are used, as for the wil harvest. Professional crayfishermen are employed by farmers fo harvesting with compensation of half the value of the liv crayfish at the market. Productivity ranges generally from 20 to 800 pounds per acre. Early season farm-raised crayfish brin over 60 cents per pound, but the price declines as the wild cro enters the market, and price averages about 25 cents per pound At 15 cents per pound, the crayfishermen find it is not wort their while to continue trapping. Pond acreage is increasing i Louisiana. There were 12,000 acres in 1969, 25,000 in 1970, an 40,000 in 1971.
Subject descriptors:
Crayfish; crawfish; development; prices; techniques; biology outlook.

124
Avault, James W., Jr.; de la Bretonne, Larry W., Jr.; Jaspers Edmonde J.
1970.
Culture of the crawfish, Louisiana's crustacean king.
Amer. Fish Farmer World Aquacult. News 1(10): 8-14, 27.
Crawfish (crayfish) biology, behavior, production, cultura techniques, market potential for food and bait ("soft craws") and studies are discussed. Crawfish are being reared in thre types of ponds: rice ponds, wooded ponds, and open ponds Cultural practices are essentially similar in all ponds. Yield range from about 200 to 800 pounds per acre generally. Louisian

crawfish pond acreage was 12,000 acres in 1969 and perhaps 25,000 acres in 1970. Live-market prices average about 25 cents per pound for the season, but early-crop farm-raised crawfish bring 60 cents per pound. The price declines if the cyclical (among years) wild crop enters the market in sufficient amount. Harvesting is by lift net and funnel traps of chicken wire, and farmers hire professional crawfishermen who operate 5 to 10 traps per acre and receive one-half of the live-market crawfish price for harvesting. No food is used. Trapping rights are leased. Capital requirements are relatively small compared to catfish, and returns to land, family labor, and management range from $50 to $100 per acre. Results of studies on mineral requirements (soil and water hardness effects) and brackish water culture are reported. Work is mentioned relating to feeding, possible meal use of crawfish waste (85% of the crawfish), crawfish peeler equipment, and crawfish as aquatic weed control agents.
Subject descriptors:
Crawfish; crayfish; development; prices; techniques; returns; markets; research.

125
Carroll, James C.; Blades, Holland C., Jr.
1974.
A quantitative analysis of the amounts of South Louisiana crawfish that move to market through selected channels of distribution.
Univ. Southwestern La., Dep. Mark., Res. Series 35, 32 pp.
Results of a 1974 survey of South Louisiana processors, seafood markets and restaurants selling crawfish items are reported. Processor volume and value of sales, distribution channels, and the ranking of various crawfish entrees served in restaurants are indicated. While the marketing channel processor to seafood market to consumer accounted for the largest percentage of processor shipments, and while 65% of the volume (62% of the value) of processor shipments consist of live crawfish, it is concluded that since "non-natives of South Louisiana are not knowledgeable concerning methods of preparing crawfish entrees at home, ... peeled crawfish tails could be more successfully marketed to restaurants in out-of-state locations than to seafood markets."
Subject descriptors:
Crawfish; crayfish; markets; marketing.

126
Franz, Robert S.
1974.
An investigation of the potential for expansion of the supply of South Louisiana crawfish and crawfish processing facilities.
Univ. SW. La., Dep. Mark., Res. Ser. 34, 20 pp.
Results of a 1974 survey of South Louisiana crawfish processors are reported. Processors handled about 14.5 million pounds

live-weight basis) of crawfish in the 1973-74 season. Prices paid and received, processor activity, utilization of capacity, expansion interest and other survey results are discussed. Ponds accounted for about one-third of their purchases. While 42,000 acres of ponds were farmed, it is estimated that 100,000 acres could be, and that with potential yields obtained in the survey, good management and optimum conditions, ponds alone could supply some 100 million pounds.
Subject descriptors:
Crawfish; crayfish; survey data; productivity; processing; prices

127
Fujimura, Takuji.
1972.
Development of prawn culture industry.
Proceedings, Kauai Aquaculture Conference, Hawaii Dep. Planning Econ. and Kauai County Off. of Econ. Dev., pp. 5-13.
During 5 years of research effort, costs of producing stockable size juveniles (about 1 cm in average length) were reduced from $6.63 to $1.93 per 1,000, not counting fixed costs. Also, a practical mass culturing technique was developed and a breeding stock was established to supply commercial needs. Topics include rearing trials and problems; growth rates; feeding, culling, cover-plant, and harvesting practices; yield, feed, survival, timing, and other data. Small (0.20 to 0.36 ha) ponds with mud or earth bottoms were used for rearing, and yields reached 3,820 kg/ha or 3378 lb/acre annually. The conversion ratios of weight of feed to weight of prawn were in the 3.3 to 3.4/1 range; feed consisted of chicken feed and fresh whole fish, and other feeds on an experimental basis.
Subject descriptors:
Prawns; techniques; biology; experiment; costs; research; biological feasibility; development.

128
Garino, David P.
1972.
Commodities-shrimp farming attracts new interest as demand outpaces supply, lifts prices.
Wall St. J., April 3, 1972, p. 18.
Because of the relatively faster growth in demand compared to supply, shrimp prices are increasing, and some researchers expressed the hope that the fledgling shrimp farming industry may someday slow the rate of price increase. Interest and activity of several large companies are indicated (e.g., Dow Chemical, Ralston Purina, and San Diego Gas & Electric, as well as Marifarms), but some companies (e.g., Greyhound's Armour & Co. subsidiary) withdrew as costs mounted. Some of the formidable obstacles to profitable operation and industry success are mentioned, such as shrimp survival, cultural methods generally, feeding, R&D, proper scale of operation, and water temperature

regulation. The views and opinions of industry and university people who were interviewed indicate that a profitable industry may be operational in say 10 years, that some of the obstacles are being overcome, or at least being attacked, and that even now, "barring a disaster, shrimp farming can be marginally successful."
Subject descriptors:
Shrimp; problems; R&D role; outlook.

129
Gary, Don L.
1974.
The commercial crawfish industry of South Louisiana.
La. State Univ., Cent. Wetland Resour., LSU-SG 74-01, 59 pp.
This report is an abridged version of a thesis submitted to Oregon State Univ., 1973, entitled "A geographic systems analysis of the commercial crawfish industry in South Louisiana." Topics include history of crawfishing, biology, cultural techniques, and various factors affecting processing plants and ponds, and their location. Information is provided on the number, type, and location of ponds, including frequency distribution graphs on the number of ponds by size and type (open, swamp, and rice-field ponds). Estimated acreage of commercially managed ponds is shown for selected years; and it grew from 40 acres in 1949 to 44,000 acres in 1973, but growth is expected to taper off. The 33 studied processing plants have annual input of live crawfish ranging from 2,000 to 450,000 pounds, and 57% of these plants are owned along with a complementary restaurant, grocery store, or fish market outlet. A consensus is that 50-acre ponds maximize returns on investment. Both total and per-acre estimated revenue, cost, and returns are shown for a hypothetical 50-acre pond operation.
Subject descriptors:
Crawfish; crayfish; acreage data; history; development; R&D role; pond culture; techniques; revenue; costs; returns; processing; outlook.

130
Helfrich, Philip.
1973.
The feasibility of brine shrimp production on Christmas Island.
Univ. Hawaii, Sea Grant Progr., Sea Grant Tech. Rep., UNIHI-SEAGRANT-TR-73-02, 173 pp.
Discussed is a scheme to culture brine shrimp on Christmas Island, the largest of the Line Islands, 1,100 miles due south of Maui Island in the Hawaiian Archipelago. Details on the island's location, weather, government, and history are given along with details on geology, physiography, lake circulation, and biology of the brine shrimp. The market potential for cultured brine shrimp is discussed. Aquarium hobbyists and consumers of the shrimp as a food source create the market. Estimated annual

sales of brine shrimp eggs in the United States, Europe, and Japan are greater than 14,000 gallons. The present U.S. retail price is $50 per gallon. The wholesale price is $25 per gallon. A pesticide-free egg would allow the food market to expand and lower the costs. Two plans, A and B, are discussed in terms of output, costs, and receipts throughout a 4-year period, including construction costs. Under plan A, tabled data shows expenditures of $0.7 million and receipts of $1.05 million. Plan B has total expenditures of $1.2 million and receipts of $1.75 million. Other tables itemize numerous other input and output items. Frozen brine shrimp is predicted to cost 17.5 cents per pound for processing, but to command a wholesale price of 30 to 35 cents per pound. With production at 1,000 pounds per day, the projected margin would total $125 to $175. Christmas Island's facilities such as labor force, ports, electrical power, fuel, and freshwater supply are also discussed.
Subject descriptors:
Shrimp; Hawaii; biology; biological feasibility; revenue; costs; returns; economic feasibility.

131
Jhingran, V. G.; Gopalakrishnan, V.
1973.
Prospects for the development of brackishwater fish and shrimp culture in India.
J. Fish. Res. Bd. Can., 30(12, part 2): 2341-2343.
Topics include: estimated actual and potential area, methods, experimental yields, research progress, estimated potential costs and returns, and development recommendations. Some 10,000 ha of brackish water area were used for fish and shrimp "trap and grow" culture in 1968 (perhaps 15,200 ha by 1973). Tidal water enters open sluices of embanked ponds, sluice gates are closed, the fish and shrimp grow for some months, and they are harvested. Yields average 200 kg/ha/year (range 100-1,000). Based on improved technology (used in experimental and pilot farm operations) estimated costs and returns for a 10 to 20 ha suggested (hypothetical) farm operation are given on a per-hectare basis. Assumed yield is 1,500 kg/ha/year of unspecified species. Experimental work mentioned relates to prawn (Penaeus monodon) mullet (Mugil parsia) and bhekti (Lates calcarifer).
Subject descriptors:
Shrimp; India; biology; revenue; costs; returns; experiment development; techniques; research.

132
Johnston, W. E.; Allen, P. G.
1974.
Technology assessment and the direction of future research: us cf computerized budgeting for lobster aquaculture.
Paper presented at annual meeting of the American Agricultura Economics Association, Aug. 1974, College Station, Texas, 28 pp

In multidisciplinary research endeavors, objectives may be clearly defined but central evaluation lacking. Additionally, where models cannot be well specified, simulation techniques are unusable. For research directed towards commercial lobster aquaculture, the application of computerized budgeting in evaluating state-of-the-arts and in assessing alternative research strategies is illustrated. (Authors' abstract; more recent results of this research are annotated under Schuur and others.)
Subject descriptors:
Lobsters; systems analysis; engineering design; costs.

133
Kensler, Craig B.
1970.
The potential of lobster culture.
Amer. Fish Farmer World Aquacult. News (11): 8-12, 27.
The author discusses past and present work with lobster culture, biological criteria, culture suitability, and problems of the lobster. The development rationale is expressed in terms of mentioning world supply-demand and price situations for this luxury-food crustacean. Hatchery efforts to augment natural stocks began in Europe in 1865 and in North America in 1885, but their effectiveness and feasibility was never established. The "golden age" of lobster culture saw as many as 20 North American stations involved, of which only 1 remained in 1950. Recent price advances and general improvements in aquaculture technology help explain the present rationale for four major and other efforts to develop the state of the art of lobster culture. Biological problems include the lobster's natural environment, temperature-related slow growth, cannibalism, territorial behavior, and possible high mortality in a culture environment, due to diet, disease, molting, cannibalism, or other factors.
Subject descriptors:
Lobsters; biology research; history; state of the art; R&D role.

134
Mock, C. R.
1973.
Shrimp culture in Japan.
Mar. Fish. Rev., 35(3,4): 71-74.
In this extract of a longer paper, growing procedures, research, production data, and some economic forces are discussed. Live shrimp are used in preparing meals in tempura fashion, helping to explain high 1971 prices for "Kuruma-Ebi" (Penaeus japonicus) shrimp. (Annotator's note: "Kuruma" prawn prices in 1965 to 1970 were 6 to 10 times the price for other prawns and shrimp in Japan.) "Kuruma-Ebi" cultured output doubled from 1964-65 to 1967-69, but was less than 1 percent of utilization in all years; natural harvest declined, but was still about five times larger in 1969; imports dominate utilization. It is not economical to

completely culture these shrimp and egg-bearing females are
purchased from commercial fishermen. Increased feed costs and
wages, and disease problems led to increased research.
Subject descriptors:
Shrimp; Japan; biology; research; techniques; production data;
import data; general description.

135
Neal, Richard A.
1973.
Progress toward farming shrimp in the United States.
Mar. Fish. Rev., 35 (3,4): 67-70.
While no commercially viable U.S. shrimp farms exist today,
growing demand and increasing prices, shrimp hatchery and far
trial efforts by private firms, government and universit
research on rearing methods, and various aspects of biology,
physiology, and nutrition all suggest that methods may b
sufficiently improved and costs sufficiently reduced to allo
operation of a profitable U.S. shrimp farming industry sometim
in the future. The proprietary nature of private firms' data an
the experimental nature of government-university data preclud
accurate cost estimates for commercial scale operations fo
publication. Yet, the experimental work does provide the basi
for quantifying some aspects of production, such as the outpu
effects of fertilizer, feed and water exchange, and th
growth-rate declines as shrimp reach 3 to 5 inches in size
Price alone would suggest growing shrimp beyond the 3- to 5-inc
size (at which size the bait shrimp price exceeds the food shrim
price), since food shrimp prices increase faster than size a
size increases. But mortality, labor, feed, an
facility-opportunity costs of the farm operation must also b
considered. The article also discusses high mortality
inefficient feed use, other problems, and problem-oriente
research.
Subject descriptors:
Shrimp; biology; techniques; research; problems; outlook.

136
Schuur, A.M.; Allen, P. G.; Botsford, L. M.
1974.
An analysis of three facilities for the commercial production o
Homarus Americanus.
Paper (number 74-5517) presented to the American Society o
Agricultural Engineers, Dec. 10-13, 1974, Conrad Hilton, Chicago
Ill., 19 pp.
Biological, physical and engineering aspects of lobste
aquaculture are integrated via a flexible computer progra
Variations in cost components of three design concepts--stacke
trays, raceway, and silo--suggest that evaluation must be withi
a systems context. Under baseline assumptions the stacked ta
proved least expensive ($3.60 per 500g). The program contai

120 variables, most of which are assumptions that can be changed. Itemized costs are shown for the three design concepts for both 24 and 30 month growth periods.
Subject descriptors:
Lobsters; systems analysis; engineering design; costs.

137
Shang, Yung Cheng.
1972.
Some economic aspects of fresh water prawn farming in Hawaii.
Proc., Kauai Aquaculture Conference, Lihue, Kauai, June 25, 1972. Hawaii Dep. Plan. Econ. Dev., and Kauai County Off. Econ. Dev., pp. 14-16.
Some information is given. (For a more complete presentation see Yung Cheng Shang, Economic Feasibility of Fresh Water Prawn Farming in Hawaii.)
Subject descriptors:
Prawns; revenue; costs; returns; investment model; economies of scale; markets; sensitivity analysis; general description.

138
Shang, Yung Cheng.
1972.
Economic feasibility of fresh water prawn farming in Hawaii.
Univ. Hawaii, Econ. Res. Cent., 49 pp.
The investment criteria of positive net present value (NPV) and break-even price in excess of expected price are explained and used. Cost estimates are based on actual hatchery data and preliminary prawn farm data. Sensitivity analysis is employed to show the effect of changes in several variables: (1) for the hatchery, three output levels, five discount rates, and two water costs (associated with the use of domestic water and well water); and (2) for the prawn farm, two yield levels, four farm sizes, five discount rates, and three prices. Economies of scale occur in the hatchery with respect to labor and other input costs and in prawn farming with respect to management, labor, feed, and other input costs. That is, according to the estimated cost data, the costs of various factors of production change in different percentages as output increases. Available information suggests that the market would be local (Hawaiian), although the potential on the U.S. mainland and Japan are discussed. While the product can be taste-test distinguished, it would likely compete with 10- to 15-count shrimp (count referring to the number of heads-off shrimp per pound), and it would be a luxury item purchased mainly by hotels and restaurants.
Subject descriptors:
Prawns; revenue; costs; returns; investment model; economies of scale; markets; sensitivity analysis; general description.

139
Wear, R. G.
1975.
SEAFDEC aquaculture: a seafood revolution in the Philippines.
Fish Farming Internatl. 2 (2): 6-11.
The discussion of plans, budgets, activities and significance of
the new aquaculture department at the Philippine headquarters of
the Southeast Asian Fisheries Development Centre (SEAFDEC)
includes information on efforts to develop the culture of Penaeus
monodon and other penaeid species. Japan provides a ready export
market, and shrimp have been harvested as a source of secondary,
supplemental income on milkfish (Chanos chanos) farms.
Experimental cultural techniques are indicated. Information is
provided on yields, prices, capital and operating costs, along
with an assessment of possible profitability on the basis of 1-ha
experimental ponds. With the SEAFDEC interest and support, 5-ha
farm ponds are being operated on a cooperative basis with farmers
to determine if yields, costs and other factors will indicate an
economically viable situation over a 5-year period.
Subject descriptors:
Philippines; R&D role; biology; economic feasibility; experiment;
shrimp.

140
Webber, Harold H.
1975.
Crustacean aquaculture in Middle America.
Mar. Fish. Rev. 37(1): 24-30.
The author discusses market, culture technology, enterpris
siting, and business plan aspects of his firm's establishment o
a large shrimp farm in Central America. The author's genera
scheme of siting criteria is specifically applied (see Webber
1972, elsewhere in this bibliography, for the scheme). Among th
aspects of the firm's business plan which are discussed are th
following: capital costs, use of a pilot scale operation (a
least 3 200-acre modules, horizontally integrated), vertica
integration, labor intensive technology, and farm management
Economic development benefits include employment, foreig
exchange, and infrastructure, but not food directly, due t
price.
Subject descriptors:
Shrimp; economic feasibility; economies of scale.

141
Welsh, James P.
1974.
Mariculture of the crab Cancer magister (Dana) utilizing fis
and crustacean wastes as food.
Humboldt State Univ., Sea Grant Publ., HSU-SG-4, 76 pp.
The objective of research reported in this paper was twofol
(1) to investigate the biological feasibility of establishi

methods of culturing crab using locally produced fish and crustacean wastes as the major food support, and (2) to investigate the possibility of holding wild-captured adult crabs in pens over long periods of time at an acceptable level of mortality loss in order to allow a more predictable supply of crabs to market, steady the price structure throughout the season, and provide a supply during periods of wild crab scarcity. In the 3-year study, local fish and crustacean wastes were chosen as food base for crab culture because they were available at minimum purchase costs ranging from 2 cents per pound for fish to free for crustaceans. Crab prices are lower in the early part of the season (Dec. to Jan.) because the catches are large. After January the catches drop steeply and the price rises with the shortage. Crab culture would accelerate the postmolt recovery period and extend the labor season of crab workers. Among other topics discussed are previous and current research on Cancer magister, stocking procedures, problems, results as to rates of meat recovery (cultured vs. wild crabs), weekly percentages of crab losses due to cannibalism, disease, etc., chemical composition of waste, and some suggestions about techniques of culture.

Subject descriptors:
Crabs; waste use; biological feasibility; state of the art.

142
Williams, Robert James.
1973.
Economic feasibility of commercial shrimp farming in Texas.
M. S. thesis, Texas A&M Univ., 57 pp.

The purpose of the research was to develop a model which would aid a prospective investor in evaluating the economic feasibility of shrimp farming. Cost and revenue data based upon assessments of individuals associated with Texas A&M University's experimental shrimp farms are used for illustration. The investment criteria return on equity and net present value are employed, along with sensitivity analysis to show the effects of changes in key variables. Key variables include land, feed, seed-stock and heading costs; number of crops per year; stocking densities; and wholesale prices. For the variates assumed, returns appeared attractive.

Subject descriptors:
Shrimp; investment model; economic feasibility.

143
Winget, Rodner R.; Maurer, Don; Anderson, Leon.
1973.
The feasibility of closed system mariculture: preliminary experiments with crab molting.
Proceedings, Natl. Shellfish Ass. 63 (June), reprint, Univ. Del., Coll. Mar. Studies, Sea Grant Publ. DEL-SG-3-74, pp. 88-92.

A recirculation system for inducing shedding in the blue crab,

Callinectes sapidus Rathbun, and preliminary experiments on crab molting are described. The most important result was the inducement of out of season molting (January-March) in the Delaware Bay area. By developing methods to molt blue crabs in the winter the soft shell industry can be pursued throughout the year. In addition, by inducing molting the year round, faster growth rates are realized and market size crabs can be obtained much quicker. It is concluded that the reported work, along with that of other researchers, establishes the feasibility of the procedure in a technical, not economic sense.
Subject descriptors:
Crabs; technology; experiment; biological feasibility.

144
Yee, William C.
1970.
Potential of aquaculture at nuclear energy centers--a systems study.
Oak Ridge Natl. Lab., Oak Ridge, Tenn., ORNL-4488, 78 pp.
(Obtain from NTIS.)
This report shows the potential merits of utilizing heated seawater from nuclear or fossil-fueled energy centers (power stations or desalting plants) for intensive aquaculture. An evaluation is made of an intensive aquaculture facility using shrimp as a model since more biological, technical, and marketing data are available for this aquatic species than for any other marine life. The analysis includes a conceptual design based on present technology, a cost estimate of a facility sited at an United Arab Republic energy center, cost sensitivity studies of the facility, and a brief market study that indicates the future export market potential of shrimp to industrialized nations. Capital and annual operating costs for the facility are shown, along with graphed functions for the sensitivity analysis which shows the effects of changes in land improvement costs, food conversion ratio, wage rates and labor productivity, price of product, and shrimp yield on annual production cost.
Subject descriptors:
Shrimp; United Arab Republic; revenue; costs; returns; markets; sensitivity analysis; engineering design; powerplant heat use.

OTHER ANIMAL SPECIES

145
Dukhnovski, M. K.
1970.
Economic efficiency of breeding herbivorous fishes in ponds (Ekonomicheskaya effektivnost' vyrashchivaniya rastitel' noyadnkh ryb v prudakh).
Rybn. Khoz. 46(11): 101-107. (Obtain translated copy on loan from NMFS).

This report compares the economic efficiency of the increasingly important herbivorous fish culture with that for carp. Output data are given, and operations in the Konstantinovka district of the Donetsk fishery combine (firm) are used for purposes of the study. Twc-thirds of the district's assets are in production ponds (totaling 44 ha), and amortization of the capital cost is allocated between fry and market fish culture. Several tables and discussion are used to indicate acreage, capital investment, labor expenditure, production, revenue, and itemized cost and return data. For example, among the comparisons made, the 18.4 ha water supply pond had a yield of 0.69 metric ton/ha of carp, and 0.19 ton/ha of herbivorous fish, but profit was 14.0% of expenditures (12.2% of market receipts) for carp and 37.8% of expenditures (27.5% of market receipts) for the herbivorous fish in 1967. This activity produced market fish. A similar comparison is made for fry production.

Subject descriptors:
Carp; herbivorous fish; firm data; revenue; costs; returns; investment; enterprise comparison.

146
Folsom, William B.
1973.
Japan's eel fishery.
Mar. Fish. Rev. 35(5,6): 41-45.

Discussed are culture methods, output (1952-70 data), marketing, recent prices (1971 to 1973), import data (1970 to 1972), quantity and value, and prices by country, import duties, and U.S. export opportunities. In the period 1952-70 output from inland fisheries remained relatively stable around 3 to 4 metric kilotons, while cultured output rose from less than 1 to over 20 metric kilotons. Juvenile eel (elver) prices increase as size decreases for culture purposes.

Subject descriptors:
Eel; Japan; techniques; production data; import data; prices.

147
Gordon, William G.
1968.
The bait minnow industry of the Great Lakes.
U.S. Dep. Int., Fish Wildl. Serv., Bur. Commer. Fish., Fish. Leafl. 608, 6 pp.

The nonaquaculture bait minnow industry of the Great Lakes is described, and methods for increasing the harvest are demonstrated by results of exploratory bait fishing activities completed by the Bureau of Commercial Fisheries. Nets, equipment, and gear are described, and improved harvesting methods are recommended as a means of increasing supplies during summer when sport fish demand is at a peak. Harvesting has been from shallow Great Lakes waters, but substantial stocks are available during the summer in deeper, offshore waters if proper harvesting techniques are applied. Such harvesting would help satisfy the demand now being partially met by hauling commercially cultured bait minnows for great distances to the Great Lakes area.
Subject descriptors:
Minnows; baitfish; natural-stock production.

148
Herrick, Samuel F., Jr.; Baldwin, Wayne, J.
1975.
The commercial production of topminnows--a preliminary economic analysis.
Univ. Hawaii, Sea Grant Rep. UNIHI-SEAGRANT-AR-75-02, 18 pp.
Based on techniques developed by the Hawaii Institute of Marine Biology, the possible commercial production of topminnows (Poecilia vittata) as an alternative to the use of Nehu (Stolephorus purpureus) for live bait in the skipjack tuna fishery is analysed. Topics include water quality, production processes, biology, facility design and economic analysis. Capital and operating costs are itemized, and other information is presented in the context of the net present value analysis of three levels of output, 3,000, 30,000 and 60,000 buckets of topminnows per year (each bucket containing about 6 pounds or about 3,000 topminnows). The largest two levels of operation were judged profitable at discount rates of 10, 20 and 30%, but the smallest, only at 10%, assuming a 20-year period of operation. Because of the preliminary nature of the data used, the authors recommend further investigation.
Subject descriptors:
Topminnows; revenue; costs; returns; economic feasibility.

149
Hudson, Stanton.
1974.
Minnow farming, an American enterprise, then-now-and the future.
Catfish Farmer World Aquacult. News 6 (1): 31, 32, 37, and 38.
Expanding recreational demand and fishing area, and decreasing wild harvests led to the increasing demand for farm-raised minnows. Yet, there are several risks and problems. The market is seasonal, with sales concentrated in the summer, demand fluctuates from year to year, and droughts or floods, which affect recreational lakes, shift demand among locations. Chroni

overproduction in the past 15 years has kept prices low; for example, small-minnow prices were $5 per pound in 1951 and $1 per pound in 1973. Fish may grow rapidly from a profitable to unprofitable size. The author views minnow farming as a typical farm venture involving large capital investment in land and equipment, with present prices allowing expansion of existing operations, but not development of separate operations. Even so, he views the future optimistically. U.S. bait fish pond area acreage is estimated to be 50,000 acres, with 29,091 acres in Arkansas, 12,900 acres in Minnesota, 1,740 acres in Mississippi, 1,500 acres in Louisiana, and 1,200 acres in Missouri.
Subject descriptors:
Minnows; baitfish; risks; problems; industry development; production data; outlook.

150
Lewis, William M.; Heidinger, Roy.
1971.
Aquaculture potential of hybrid sunfish.
Amer. Fish Farmer World Aquacult. News 2 (5): 14-16.
On the basis of certain characteristics established in biological experiments and the researchers' assessment of product characteristics relative to catfish, it is expected that hybrid sunfish will be produced in substantial quantities for food and recreational markets. With respect to density control in ponds, feed response, oxygen-depletion tolerance, growth rate, and other measures, for all of which some data are provided, hybrid sunfish are judged suitable for commercial production.
Subject descriptors:
Hybrid sunfish; biology; biological feasibility; experiment; method evaluation; outlook.

151
Martino, K. V.; Mustafin, R. M.
1972.
The economic effectiveness of acclimatizing grass carp in the lower reaches of the Volga (Ekonomicheskaya effektivnost' akklimatizatstii belogo amura v nizov'yakh Volgi).
Ryb. Khoz., 48(9): 86-87. (Copy of translation available on loan from NMFS.)
Expenditures and prime cost of breeding and raising grass carp from the egg to its release into the Volga are discussed. The prime cost of raising one grass carp underyearling from the egg to its release is 2 kopeks. The cost of 1 kg of grass carp raised in the river and capable of being fished ranges from 1.61 rubles to 2.14 rubles, depending on the size of the stock, specified assumptions, and other factors. These costs are declining and were 37% lower in 1970 than in 1966. Product form affects profitability. Adding fishing (harvesting) and delivery costs (0.48 rubles) to prime costs brings total cost (2.09 to 2.62 rubles) above the market price for wild carp (0.67 rubles).

Adding prime costs and costs of fishing, delivery, and processing (C.77 rubles) would allow a profit only at the specified higher stock amount, given certain assumptions because the wholesale market price is 2.82 rubles (with costs totaling 2.37 and 2.91 rubles per kg for the two stock amounts) for fillets.
Subject descriptors:
Grass carp; Russia; economic feasibility; method evaluation; revenue; costs; returns.

152
Minamisawa, A.; Sakai, H.
1969.
Cultivation of a hamachi (Seriola quinqueradiata, Temminck et Schlegel). (Hamachi no yoshoku.)
Suisan Zoyoshoky Sosho 18: 1-56. (Copy of translation available on loan from NMFS.)
Various aspects of Japanese hamachi culture (young or infant yellowtail, Seriola quinqueradiata) are discussed. The fry (mojako) are caught in coastal waters; hatcheries have not yet proven feasible. Three types of enclosures are used: diked ponds, net pens (fenced-off areas), and smaller net enclosures (suspended net "boxes", etc.). The advantages and disadvantages of each are discussed, along with design variations. Other topics include fry planting (numbers of fry caught and planted are given by Prefecture for the years 1965-68), environment, feed and growth, diseases, a 12-month description and schedule of culture activities, marketing, and enterprise management considerations. Prices are affected by season, quantity of fish, market (city), size of fish, freshness and other factors. The fry are caught and planted about early May, and may be harvested about August when they reach 300 g. Winter prices (October to January) are lowest. The fish are killed at the production site beginning in October or may be shipped by boat, rail truck, and even airplane. At-market killing and other preference factors affect price. Prices are highest in the spring when the overwintered fish are marketed. As to management, the importance of feed and labor costs and their reduction are discussed, along with cooperative forms of business. Itemized costs are shown for farms using 4,000 to 20,000 fry (Ehime Prefecture, 1967). By-item percentages of cost are shown for the three methods of culture, based on a sample of 37 firms, Seto Island Sea, 1967.
Subject descriptors:
Yellowtail; hamachi; Japan; methods; techniques; biology; sts; method comparison; economies of scale.

153
Priddy, John M.; Culley, Dudley D., Jr.
1972.
Frog culture industry, past, present, future?
Amer. Fish Farmer World Aquacult. News 3(9): 4-7.
Bullfrogs are used for education and research as well as food.

The research market has requirement or preferences for particular strains, and consequently the U.S. frog culture industry has supplied pond or breeding stock, but its price (costs) have kept it out of the direct-use aspects of this market. Frogs for food (frog legs) and 50% of those used for educational purposes have been imported from Japan and India, where there have been successful pond culture industries since the the early 1900's. However, the industries in these countries face increased domestic demand, destruction of frog habitat, DDT contamination, or over-exploitation in varying combinations. Growing demand by education and research groups has accelerated depletion of U.S. wild stocks to the point where biological supply houses indicate that they will be unable to justify collection and marketing within the next 10 to 15 years.
Subject descriptors:
Frogs; indoor culture; demand; techniques; problems.

154
Shang, Yung C.
1974.
Economic potential of the eel industry in Taiwan.
Aquacult. 3(4): 415-423.
Capital and operating costs are detailed. Sensitivity of annual profits and return on investment to changes in survival rate, eel price and seed eel price is demonstrated. The analysis is based on data obtained in a 1973 survey of 30 eel farms. An aggregate demand function for eel in Japan is estimated. Although demand is growing, and Japanese eel imports come primarily from Taiwan (96% in 1972), constraints on the supply of seed eel, along with possible competition from the Peoples Republic of China in the Japanese market represent significant problems.
Subject descriptors:
Eels; Taiwan; costs; revenue; returns; demand analysis; Japan.

155
Shang, Yung Cheng; Iversen, Robert T. B.
1971.
The production of threadfin shad as live bait for Hawaii's skipjack tuna fishery: an economic feasibility study.
Univ. Hawaii, Econ. Res. Cent., 42 pp.
Nehu, a small anchovy, has been the predominant bait used in the Hawaiian skipjack tuna pole-and-line fishery, but catching nehu requires about 30 to 40% of the fleet's time and nehu mortality is high. NMFS research has shown that the threadfin shad is a potential substitute and can be cultured in ponds. Since no nehu bait market exists, the opportunity cost method, and comparison of tuna catching rates and mortalities between the two bait fishes were used to estimate bait value. Investment feasibility was determined using the net present value (NPV) criterion and estimated data, which are shown in tables and figures. The NPV analysis involved two output levels, two levels of shad

mortality, five discount rates, two sources of water, two operating or evaluation periods, and two modes of operation. It was concluded that the higher output rate only was economically feasible. Discount rates, mortality rates, and terms of operation, but not source of water, significantly affect profitablity. Because the study was based on preliminary information, further research in specified areas is suggested.
Subject descriptors:
Nehu; baitfish; revenue; costs; returns; investment model; biological feasibility; economic feasibility; sensitivity analysis.

156
Shpet, G. I.
1972.
Comparative efficiency of fish culture and other agricultural activities per unit of area used.
Hydrobiological J. 8 (3): 46-51.
The author compares the output per unit of area used for pond fish culture (carp) and livestock (cattle for beef) in the U.S.S.R., using two purely physical, not economic measures. Concepts and data used relate to such things as food chain links (plants, herbivores, and carnivores), input-output factors, energy (calorie) consumption or use, and product form (live, meat, and protein weight of output). Natural carp productivity is 200 to 300 kg/ha; pond fertilization raises this to 300 to 600 kg/ha, and supplementary feeding, to 900 to 1,200 kg/ha, which is a conservative yield, given that some of the best Ukrainian fish farms achieve 2,000 kg/ha or more. In the carp-cattle comparisons, adjustments are made to account for acreage used to grow the carp feed, which is assumed to be human food-quality wheat grain, although in actual fish farming practice grain waste and oil-seed meal not usually acceptable as human food are fed to carp. Using several indices, it is concluded that carp are physically, (not necessarily economically) more productive than cattle. For example, carp produce more live, meat, and protein weight of product per hectare (of hay-producing area for cattle and pond plus wheat-producing area for carp). Similarly, output per fodder unit, a measure of weight gain per kilogram of feed input, is greater for carp, and this does not count the effect of natural pond productivity of carp. Even on the basis of natural pond productivity (the 200 to 300 kg/ha), carp win, and ponds may occupy area that is really not suitable for other agricultural purposes.
Subject descriptors:
Carp; beef cattle; productivity; comparison.

157
Smith, Theodore Isaac Jogues.
1973.
The commercial feasibility of rearing pompano, Trachinotus carolinus (Linnaeus), in cages.
Univ. Miami Sea Grant Progr., Tech. Bull. No. 26, 62 pp.
Pompano are believed to be suitable for aquaculture, but success has been limited. This study was conceived to rear pompano in cages at five stocking densities. Estimates are made of costs (for cages, labor, feed and fingerlings, but not for water column leasing, on-shore installation, equipment and supplies, and marketing) and gross revenue. The estimates are based on the researcher's study and other information. Present markets are for a 1-pound fish, but an 8- to 10-ounce pan-sized fish may be acceptable and would be advantageous, since growth seems to slow once this weight is reached. Higher prices are assumed because the quality of the cultured fish is thought to be superior to wild fish. Factors relating to cost reduction are discussed: stocking, wild-fish usage of food (from outside the cage), the possibility of conditioning pompano for noncage culture, fingerling cost, feed conversion rates, and other factors.
Subject descriptors:
Pompano; biology; biological feasibility; experiment; economic feasibility; markets; revenue; costs.

158
Sneed, Kermit E.
1971.
The white amur: a controversial biological control.
Amer. Fish Farmer World Aquacult. News 2(6): 6-9.
The article discusses mechanical and biological vegetation control as alternatives to chemical controls. Mechanical methods involve the physical removal of weeds from lake areas. These methods are expensive, time-consuming, and inefficient. Two possible methods of biological control are available, pathogenic viruses and herbivorous fish. Viral methods are still in experimental stages of development and at present are not feasible. Among the herbivorous fish, the white amur (Ctenopharyngodon idellus) seems most promising. Native to Asia, it is a member of the Cyprinidae family, which includes carp and minnow species. These fish grow at a rapid rate and may become 4 feet long and weigh up to 100 pounds over a period of several years. They begin to feed on aquatic vegetation when about 1 inch long. The white amur eats as much as two to three times its body weight per day. Also mentioned are the possibilities of sport and commercial fishing, reproduction, possible adverse effect on lake habitats, and control.
Subject descriptors:
White amur; biology; biological feasibility; problems; benefits.

159
White, James T.
1970.
Minnows--by the million.
Amer. Fish Farmer World Aquacult. News 1(9): 8-11 and 27.
Information is given on sport-fishing bait demand for minnows, farm location factors, culture methods, production, development, and history of the I. F. ("Fay") Anderson minnow farm operation. Demand growth relates to increased leisure time and expenditures, and expanded reservoir water area and fish stocking.
Subject descriptors:
Minnows; baitfish; recreation; demand; techniques; state of the art.

160
Yamamoto, Tadasu.
1972.
Raising young yellowtail in Japan.
Economic aspects of fish production, International Symposium on Fisheries Economics, Paris, Nov. 29 to Dec. 2, 1971, O.E.C.D., pp. 349-362.
Production volume data (natural, cultured, and total) for 1965-69, more complete data by Prefectures for 1969, culture technique, and cost information are given. Growing demand, complemented by Japanese Government policies to assist coastal fisheries, has prompted increased output of young, usually live-shipped yellowtail (1-yr., 1-2 kg at market stage). Output doubled between 1965 and 1969, and is expected to account for an increasing share of total Japanese production of yellowtail. Natural fry are used. Embanked ponds, net-enclosed ponds, floating net cages, and other devices are used. The table of estimated itemized costs indicates that food is the largest cost item (49% of gross revenue); profit is next (21.7%), as computed after deducting fry, food, wage, medicine, repair, depreciation, interest, and selling costs from gross.
Subject descriptors:
Japan; yellowtail; production data; supply; revenue; costs; returns; outlook.

161
Zaidinar, Yu. I.
1970.
Calculation of the economic effect of commercial fish culture (Raschet ekonomicheskogo effekta promyshlennogo rybovodstva).
Rybn. Khoz. 1970(11): 108-117. (Copy of translation available on loan from NMFS.)
Analysis of the economic effect of fish culture enterprises is discussed. Methods and concepts of determining cost, profit and return on investment (as developed by the U.S.S.R. Academy of Sciences) are illustrated using 1966 data for sturgeon-breeding (fry release or hatchery) enterprises in the basin of the Asov

Sea. The principal parameters that determine the economic efficiency of investment are output and its value, labor productivity, production costs and capital returns.
Subject descriptors:
Hatcheries; sturgeon; U.S.S.R.; method evaluation; benefit-cost analysis; economic concepts; methodology.

SEAWEEDS

162
Dawes, Clinton J.
1974.
On the mariculture of the Florida seaweed, Eucheuma isiforme.
Univ. S. Fla., Sea Grant Rep. No. 5, 10 pp.
Biological information, and growing demand for the specific product (iota carrageenan) from Eucheuma isiforme, along with comparison of yields from tank and field culture suggest that a carefully designed pilot project to ascertain costs and returns under cultured conditions is merited. Under the author's specified assumptions, gross revenue per square meter of growth area per year would be $9.72 for tank culture and $0.16 for dense, wild populations in the Florida keys. While the author discusses aspects of cost and production, he cautions that actual production under cultured conditions is necessary for determining economic feasibility.
Subject descriptors:
Seaweeds.

163
Doty, Maxwell S.; Alvarez, Vicente B.
1975.
Status, problems, advances and economics of Eucheuma farms.
Mar. Tech. Soc. J. 9(4): 30-35.
Eucheuma farming has been successful only in the Philippines to date. While it is likely that this country could produce as much as twice last year's world supply, past interruptions of market flows in other countries suggest that economy and stability might be achieved if production occurred in several economically and politically independent countries. Among the biological problems in farming are seasonality and senescence. A recently introduced strain may overcome part of the difficulty. Cost and return information is incomplete for any farm anywhere for a given year or farm cycle. Costs are low relative to gross revenue. For family farms the input is largely labor, with nominal capital investment, and labor opportunity costs are low.
Subject descriptors:
Seaweeds; Philippines; problems; revenue; costs.

164
Doty, Maxwell S.; Alvarez, Vicente B.
1973.
Seaweed farms: a new approach for U.S. industry.
Proceedings, 9th Annual Conference, Marine Technology Society, Washington, D. C., Sept 10-12, 1973, pp. 701-708.
The authors discuss the demand for farmed seaweed; establishment of successful indigenous, private, individually operated 1 ha farms (140 farms in early 1973) in part of Southeast Asia; farm production methods, output, costs, and returns; labor input and other data; and the institutional setting required. Demand for the marine colloid carrageenin led to overharvesting and destruction of natural seaweed (Eucheuma) sources in the primary supply area, Southeast Asia. Success of the program is due to government, university and industry support and interest.
Subject descriptors:
Seaweeds; Southeast Asia; R&D role; input-output ratios; revenue; costs.

165
Ffrench, Rudolph A.
1972.
The demand for Canadian seaweeds with special reference to Irish moss.
Canadian J. Agri. Econ. 20(2): pp. 1-6.
A demand model is presented for carrageenin (one of several food additives used for its emulsifying, stabilizing and gelling characteristics), from which the demand for Irish moss derives. The characteristics of the Canadian seaweed industry, and the carrageenin market are discussed, along with the demand equations and their statistical properties, data (1953-68) sources and limitations, equation-forecasted and actual demand, and the implications of a possible short-run growth decline (i.e., the management implications of reduced demand and income in the Maritime Provinces).
Subject descriptors:
Seaweeds; demand analysis.

166
Hunter, Charles J.
1975.
Edible seaweeds--a survey of the industry and prospects for farming the Pacific Northwest.
Mar. Fish. Rev. 37(2): 19-26.
The culture of seaweeds offers the possibility of increasing the resource base for producing certain food, fiber and chemical products. The U.S. market for industrial products from seaweeds is well established, but current prices of the leading natural raw materials, kelp and Irish moss, would require a high-bulk, low-cost product, if seaweed culture for this market were to become competitive. However, the smaller market for edible

seaweeds appears promising, both for domestic U.S. consumption and export. Tables and graphs are used to indicate Japanese production, trade, consumption and prices, and U.S. imports.
Subject descriptors:
Seaweeds; production data; trade data; consumption data; prices; outlook.

167
Parker, Henry S.
1974.
The culture of the red algal genus Eucheuma in the Philippines.
Aquacult. 3(4): 425-439.
The author discusses uses, culture-method investigations, biological factors, harvesting pressures on natural beds, cultivation potential and methods, current productivity and economics of farming, and the outlook. Based on data from a pilot farm and specified assumptions, revenue, costs and returns are estimated for a family farm using a two-module operation. Each module consists of 200 net structures and occupies about 0.25 ha. Allowing for purchased or leased nets, other capital equipment, and necessary farm tools, it is estimated that most of the gross revenue would accrue to the farmer and his family for labor and management input. The work is familiar to the area's people, the culture is suited to many parts of the Philippines, and the product has a ready market. Labor returns exceed those in alternative pursuits. Some problems are indicated.
Subject descriptors:
Seaweeds; Philippines; revenue; costs; revenue; returns.

168
Silverthorne, Wesley; Sorensen, Philip E.
1971.
Marine algae as an economic resource.
Preprints of the 7th Annual Conf. of the Mar. Tech. Soc., Wash., D. C., August 16 to 18, 1971, pp. 523-533.
The present study is designed to complement the many widely-known surveys of the economic value of marine animal and mineral resources. The total market value of the world's current annual production of unprocessed seaweeds is estimated to be $350 million. Estimates of the quantity and value of world production of important seaweed products are also given and prospects for further growth considered. Despite much speculation concerning the potential for food and drugs from marine algae, the evidence presented in this paper indicates that seaweed will continue to contribute only marginally to human nutrition and medication in the decade ahead. Its major uses will continue to be as a specialty food in the Orient and as the raw material for the production of specialized colloids, fodder, and fertilizer supplements in the industrialized countries. Furthermore, the large amounts of labor involved in present methods of cultivation of marine algae lead us to conclude that such intervention is

only feasible for algae which are either extremely valuable or uniquely tractable, and are therefore not likely to produce any substantial change in the level of utilization of the marine algal resource. (Authors' abstract.)
Subject descriptors:
Seaweeds; world; production data; demand; supply; uses.

169
Tanonaka, George.
1973.
Summary assessment on the industry and market for seaweed products in the world and United States.
Natl. Mar. Fish Serv., NW Fish. Cent., unpubl. manuscr., 44 pp.
The U.S. and Japanese seaweed product industries and markets are discussed using numerous tables and figures, and it is concluded that prospects may be better for a cultured seaweed industry in the United States if the food market is served. Lower prices for seaweed raw material for the industrial products market, plus its organization, size and structure might not be conducive to development of culture. Extensive data on the Japanese seaweed situation indicates culture production for some kinds of seaweeds. Japan is the world's largest producer and consumer of seaweed food products. U.S. industrial market use of marine colloids from seaweeds account for an estimated 1/2 or more of world output of algin and carrageenin, but only 2-5% of the world agar output. The "industrial" market serves food, medical, pharmaceutical and other processors or manufacturers. Some seaweed is used as meal or fertilizer.
Subject descriptors:
Seaweeds; Japan; U.S.; supply; production data; import data; uses; markets; outlook.

GENERAL

170
Allen, George; Conversano, Guy; Colwell, Bryan.
1972.
A pilot fish-pond system for utilization of sewage effluents, Humboldt Bay, Northern California.
Calif. State Univ., Humboldt, Mar. Advisory Ext. Serv., Sea Gran
Progr., HSU-SG-3, 25 pp.
This paper documents all out-of-pocket and other costs in th construction of two experimental fish ponds. These ponds will b fertilized with waste materials to enhance fish growth. Engineering, construction, and environmental problems ar discussed. Detailed descriptions of the project site as well a of the construction process itself are provided. Th out-of-pocket and other costs are divided into categorie

according to source of funds. The total cost of the project is $53,732. Nine recommendations concerning future construction of such facilities are outlined. Several tables itemize all costs in detail.
Subject descriptors:
Sewage effluent use; problems; pond culture; experiment; facility; engineering design; costs.

171
Anderson, Lee G.
1973.
An economist looks at mariculture (the assessment of human needs and some problems of applying technology: the mariculture case).
Mar. Tech. Soc. J. 7(3): 9-15.
Topics include economists' approaches to need and demand, mariculture development, and interdisciplinary research strategies in measuring and determining the significance of spillover effects (externalities) of new technology. Social and/or market willingness to pay is posed as a guide to assigning priorities to competing and multiple demands ("needs" qualified), so long as market imperfections are recognized as limitations. Following a discussion of the technological barriers to mariculture development, previous estimates (Anderson and Tabb, 1970) of return on investment in shrimp mariculture are reconsidered to demonstrate the importance of underlying data. The effects of higher prices, two instead of one annual food crop, white instead of pink shrimp, and other changes are considered, all with a caution to recognize data limitations.
Subject descriptors:
Concepts; methodology; evaluation; market role; public sector role; sensitivity analysis; externalities.

172
Anonymous.
1973.
Aquaculture in Canada, the opportunities and the risks.
Canadian Fishermen Ocean Sci. 59(4): 18-21.
The discussion at a government-industry seminar (Freshwater Institute, Winnipeg, Manitoba, May 31 to June 1, 1973) is summarized. Opportunities for commercial development to 1985 are identified, and priorities are assigned on the basis of demand outlook, technical and economic feasibility, and social payoff (article lists species ranked into three groups, and opportunities in supportive and ancillary service industries are listed unranked). Legal, institutional, policy, and attitudinal constraints are listed. R&D needs and priorities are given in a high-priority group (ranked as follows: diseases and parasites, genetics, applied research, and culture systems), and in a low priority group (unranked, as follows: marketing, pollution, economics, thermal and nutrient effluents, information flow, pilot projects, environmental management, and improved

harvesting). The question of having new financial instruments to help absorb risks was discussed, but not resolved at the conference.
Subject Descriptors:
R&D priorities; Canada.

173
Anonymous.
1975.
Economic impact of pollution abatement regulations on the fis farming industry.
Aquacult. Fish Farmer 2(4): 8, 9, 11, 15, 17, 19 and 27.
Comments by Donald R. Whitaker (at the Commercial Fish Farmers Convention, Little Rock, Ark., Jan. 31, 1975) and Bruce C. Moorehead (at the U.S. Trout Farmers Association, Huron, Ohio, Oct. 6, 1975), both of the National Marine Fisheries Service, ar reported. National, fish processing industry and fish farmin industry costs, economic effects and problems are discussed, using available data. Economies of scale in abatement place th smaller firm at a cost disadvantage. The industry may experienc capital financing problems, suffer from competition by oversea producers not required to install abatement equipment, an experience plant closures.
Subject descriptors:
Effluent guidelines; problems; costs.

174
Anonymous.
[1972].
Fisheries statistics of the Phillipines, 1971.
Phillipines Dep. Agri. Nat. Resour., Bur. Fish., Econ. Inform. Div., 107 pp.
Table 1 of this general fishery statistics publication show fishpond output quantity and value, along with that fo commercial fishing, municipal fisheries, and sustenance fishing and the total for 1951 to 71. Fishponds have the highest averag price. Table 24 indicates for 1971 the regional, provincial, an national data on privately owned, leased and total area an output; and swamplands available for development (freshwater an mangrove area). Table 25 indicates area, investment (estimate at 2,000 pesos/ ha), men employed (estimated at one man/ha) production quantity and value, all for the years 1967-71. Durin the years 1967-71, fishpond area increased from 0.140 to 0.17 million ha and the value of output from 135 to 328 million pesos By definition, fishponds "include all developed brackishwate ponds where juvenile of immature bangos (chanos-chanos) or othe kinds of fish and crustaceans are introduced, fed, protected, an eventually caught."
Subject descriptors:
Philippines; production data; acreage data; investment data.

175
Anonymous.
1969.
Fish farming today, a rapidly expanding multi-million dollar business.
Amer. Fish Farmer 1 (1): 11.
Fish farming is expanding, and there is interest in growing mullet, salmon, bass, carp, crayfish, and other species, in addition to the more familiar species, trout, catfish, and bait minnows. It is expected to become a major food supplier; demand is assumed on the basis of growing U.S. fish consumption and dependence on imports. Recreation demand also exists, and fish farming has an economic impact on local communities. Estimated data on investment, output, total farm (primary producer) value and total retail value are given for trout, catfish, bait minnows, oysters, and crayfish.
Subject descriptors:
Development rationale; outlook; markets; benefits; investment; supply.

176
Anonymous.
1974.
The fish farming market.
Obtain copies from Frost & Sullivan, Inc., 106 Fulton Street, New York, New York 10038, 197 pp.
Markets are analysed and forecast through 1982 for catfish, trout, crawfish, shrimp, clams, oysters, salmon and lobster. Also, the chapters on catfish, trout, crawfish and salmon detail cultural methods. Other chapters are devoted to marketing strategies, fish processing, fish feeds, and equipment requirements and developments. (Based on the firm's book availability announcement.)
Subject descriptors:
Trout; catfish; salmon; crawfish; shrimp; lobsters; clams; oysters; markets; marketing; forecasts.

177
Anonymous.
1973.
Fish from farming.
Fish Farming Internatl. 1 (1): 14-15.
Tables are presented subdivided according to country for estimated production of fish, shrimps and prawns, and mollusks.
Subject descriptors:
World; production data.

178
Anonymous.
1973.
International developments in fish production.
O.E.C.D., Paris, 179 pp.
Contents include: discussions for regional oceanic waters, certain fisheries and fish culture with respect to member country fishing activity; a survey of world fishing capacity; and appendix tables. Growing demand for fishery products, and natural-stock supply growth limitations and problems are the primary justifications for fish culture development. Limitations include high ratios of initial investment to annual output (perhaps 2:1 or 3:1) compared to natural stock harvesting firm ratios (perhaps 0.3:1 to 1:1), additional investment during the start-up period when money outflow exceeds money inflow (negative net cash flows), technology problems, and risks. A belief that cultured output could be increased fivefold by 1985 is viewed more in the realm of technical than of economic possibility.
Subject descriptors:
General description; outlook; development rationale.

179
Anonymous.
1973.
NOAA aquaculture survey, 1972, summary report to participants. (Also called the Mardela report.)
Burlingame, Calif., Mardela Corp., a Sea Grant project report, 60 pp.
The objective "was to define priority research areas in order to move from the laboratory to commercially viable aquaculture at the earliest possible time." Twelve 1-day regional workshops were held involving some 180 participants from universities, business, and government, so as to "achieve a representative cross section of individuals and organizations active in the region," although the "(e)xpertise and experience of respondents lay mostly in the biological disciplines." Preworkshop questionnaires and structured meetings were used to identify transition obstacles for marine, anadromous, and brackish-water species, but not for aquarium and freshwater species. Briefly, three general areas of concern are detailed: policy and organization, other nontechnical factors, and technical needs. Research priority needs and feasibility evaluations are scaled in tables based on participant responses.
Subject descriptors:
Development rationale; state of the art; R&D priorities; constraints; problems; outlook; conference; survey data; species selection.

180
Anonymous.
1974.
[Production estimates:] though still in early stages, fish farms could be major protein source by 1990.
U.S. Dep. Commer., Commer. Today 5(4): 12 and 13.
Based upon available information and opinions of specialists in different parts of the country, aquaculture production for various species was estimated (in "A draft outline for the National Fisheries Plan," Natl. Mar. Fish. Serv., 1974, 225 pp.) for the 1969-73 period and for 1990. For 1969-73, the estimates are as follows (in millions of pounds, round weight, except for shell mollusks): salmon, 23; oysters, 20; shrimp, 0.5; freshwater prawns, 0.005; clams, 2.6; trout, 35; catfish, 50; and crawfish, 10. These amounts total 141.1 million pounds; those for 1990 total about 1.2 billion pounds.
Subject descriptors:
Production data.

181
Anonymous.
1973.
Report of Pacific Island mariculture conference.
Univ. Hawaii, Hawaii Inst. Mar. Biol., Coconut Island, Kanehoe, Hawaii, Feb. 6-8, 1973, 21 pp.
This paper summarizes the objectives, procedure, and recommendations of a conference in establishing a course of development for mariculture programs in the Pacific Islands. First priority organisms include sea turtles, siganids, mullets, milkfish, mollies, cardinalfish, and other baitfish. Second-priority vertebrates are Mahimahi, goatfishes, and jacks. An explanation of the selections is outlined. The same procedure is followed in the discussion of invertebrates. Top-priority invertebrates are Malaysian prawn, brine shrimp, marine shrimp, and oysters. Second priority invertebrates include coconut crab, northern lobster, mangrove crab, pearl oyster, and Tridacna clams. The rejected species are also outlined and listed as spiny lobsters, small clams, octopus, mussels, Triton, and Trochus. Additional priorities are listed to emphasize certain elements of technology. Estimates of the levels of funding and effort are given for each top-priority species in both the vertebrate and invertebrate categories. Organizations willing to assist in funding and effort are also listed.
Subject descriptors:
Pacific Islands; species selection; R&D role; R&D priorities.

182
Anonymous.
1963.
Rural recreation enterprises for profit (an aid to rural area development).

U.S. Dep. Agri., Agri. Inform. Bull. 277, 44 pp.
This bulletin indicates opportunities for development in rural areas on privately owned land and indicates services available from USDA. Financial statements (investment, annual income, and annual expenses) are contained in the appendix for five examples of enterprises, including fishing lakes in the Midwest, and the section on income discusses each example. While the bulletin is addressed to private land owners and operators, it is also a comprehensive guide for a prospective investor, and it briefly discusses the numerous factors involved in making an investment decision.
Subject descriptors:
Recreation; fee fishing; revenue; costs; returns; prospectus factors.

183
Anonymous.
1973.
Sea fish farming progress.
Fish Ind. Rev. 3(2): 2-6.
Initiation of White Fish Authority (WFA) R&D in aquaculture and progress in several areas are discussed. Early experimental work to develop and cost a mass hatching and rearing technology for plaice and dover sole in 1961-68 was the basis of beginning operations at a WFA fish farm. There are hatchery development and demonstration operations for plaice, dover sole, lemon sole and turbot, listed in order from most to least successful. Grow-out (from hatchery to market size) of plaice and dover sole has been shown to be technically and biologically feasible in high-density, open-sea mesh enclosures and in onshore tanks using powerplant thermal effluent to warm the water. Cultured plaice have also been subjected to successful tests of consumer and market acceptability. While information is not yet sufficient to demonstrate commercial feasibility of large-scale culture operations, a model has been developed into which data can be fed to show the effect on cost per unit of output (average cost) for purposes of managing R&D funds and projects.
Subject descriptors:
Britain; state of the art; public sector role; R&D role; R&D evaluation; plaice; dover sole; lemon sole; turbot.

184
Anonymous.
1972.
Summary of proceedings for the aquaculture conference, Honolulu, Hawaii, Nov. 9 to 10, 1972, Environmental conferences on public understanding of science in Hawaii.
Univ. Hawaii, Cent. Eng. Res., 60 pp.
Some 27 speakers' presentations are given or summarized (in 48 text pages) for the five-session conference. Sessions included the topics: aquaculture background for Hawaii, constraints to

aquaculture in Hawaii, the future of aquaculture in Hawaii, Hawaii's role in assisting development in the Pacific basin. Speakers' presentations included items of interest to economists, even though economics and marketing are mentioned specifically in only two of the presentation titles.
Subject descriptors:
Hawaii; outlook; R&D role.

185
Asakawa, Kenji.
1961.
Inland water fishing in Communist China.
Development of the Fishing Industry in Communist China, pp. 24-45. (Copy of translation available on loan from NMFS.)
The author discusses the growth of inland water fishing in the Peoples Republic of China. Prior to 1957, most of the output increase came from expanded fishing of inland waters, and this is associated with land reform (1950-52), the formation of cooperatives (virtually completed for fishermen by 1956), and Government policies during the first 5-year plan (1953-57). After 1958, communes, water resource projects, increased emphasis on the development of agriculture and fishing after the first 5-year plan, and the nation's climate and water endowments are cited in explaining the growth in output of fish breeding [here, assumed to mean freshwater aquaculture]. Other factors of importance are the alteration of consumer tastes and production activities, improved breeding techniques, and the locational advantage of fish breeding relative to the newly industrialized inland cities. Inland water fishing output was about 0.37 to 0.45 million metric tons in 1936, or about 25% to 30% of the nation's total fish catch. In 1959, the inland water catch came to 2.28 million metric tons (45%) of the nation's total catch, 5.02 million metric tons, freshwater aquaculture accounting for 0.81 million metric tons (16%) of this. Problems include the adequacy of seed stocks, water availability during droughts, expected deterioration of water quality in industrialized areas and the inability of freshwater aquaculture production growth to keep pace with fish consumption growth. It is expected that the nation will turn to ocean fisheries for increased production, since the maximum water area available [allocated?] for inland fish culture is 3.33 million ha, of which 1.0 million ha were in use in 1957, 2.0 million ha in 1958, and 3.0 million ha in 1959.
Subject descriptors:
Peoples Republic of China; history; production data; country data; development rationale; institutions.

186
Bardach, John.
1972.
Some remarks on aquaculture.
Proceedings, Fourth National Sea Grant Conference, Madison, Wis., Oct. 12 to 13, 1972, Univ. Wis., Sea Grant Communications Off., Sea Grant Publ. WIS-SG-72-112, pp. 83-88.
Interest in aquaculture has increased and will increase further, given the problems created by rapid human population growth and the growing, but finite potential output of protein. Diverse problems must be recognized in aquaculture's development. A schema of four phases is presented, during which a decision to proceed or discard a species can be made. The four phases include species selection, biological research, field trials, and assessment of socio-economic factors. Phases are sub-divided, and indicate a multidisciplinary approach, with government-supported R&D, and government-industry partnership ventures suggested at various steps.
Subject descriptors:
Development planning; development rationale; R&D role; problems; concepts.

187
Bardach, John E.; Ryther, John H.; McLarney, William O.
1972.
Aquaculture; the farming and husbandry of freshwater and marine orginisms.
New York, John Wiley and Sons, Inc., 868 pp.
This text explains and describes most, if not all, aquatic plants and amimals that are cultivated for food and the methods by which this is accomplished. The book also includes biological and ecological considerations of the organisms, the current and projected state-of-the-art of their cultivation, and yields, diseases, and other problems.
Subject descriptors:
State of the art; world; biology; revenue; costs; returns; methods; techniques; problems; research; bibliography; input-output data.

188
Bardach, John E.; Ryther, John H.; McLarney, William O.
1972.
General principles and economics.
Ch. 1 of their aquaculture; the farming and husbandry of freshwater and marine organisms. John Wiley and Sons, Inc., pp.1-28.
The economics of particular aquaculture ventures are considered. The focus is on costs of production, rates of return of investment, price cross elasticities of demand among fishery products, and the supply and demand for various species. Comparisons are made among countries engaged in aquaculture as t

capital and labor intensity, and trade outlets internationally.
Subject descriptors:
World; revenue; costs; returns; demand.

189
Bell, Frederick W.; Nash, Darrel A.; Carlson, Ernest W.; Waugh, Frederick V.; Kinoshita, Richard K.; Fullenbaum, Richard F.
1975.
A world model of living marine resources.
Walter C. Labys, editor, Quantitative models of commodity markets. Cambridge, Mass., Ballinger Publishing Co., pp. 291-323.
This study integrates relevant biological and utilization factors into one model of the world demand and supply for seafoods. Decennial projections of anticipated consumption and prices are made for the period 1970 to 2000 within the framework of the model. Fish studied include tuna, salmon, groundfish, halibut, sardines, shrimp, crabs, oysters, clams, scallops, other food fish, and reduction fish (for oil and fishmeal). With the exception of sardines, oysters, clams, and scallops, it is estimated that all of the species will reach the point of maximum sustainable supply (MSS, not necessarily the same as maximum sustainable yield, MSY) in the period 1985 to 2000. Aquaculture is specifically considered in the projections for oysters, clams, and salmon (hatcheries only).
Subject descriptors:
World; demand analysis; supply analysis; bio-economic model; conventional fisheries; aquaculture; production data; methodology.

190
Bell, Frederick W.; Canterbery, E. Ray.
1976.
Aquaculture for developing countries. a feasibility study.
Cambridge, Mass., Ballinger Publishing Co., forthcoming. (The authors are with Dep. Econ., Fla. State Univ. and provided a copy of a preliminary draft, 138 pp., as submitted to U.S. Dep. State, Agency for International Development, under contract, 1974.)
The authors selected 14 presently cultured plant or animal species and 90 less developed countries to test hypotheses about the feasibility of technology transfer of aquaculture operations. Species and country groupings are employed in accord with combined scores which are based upon separate scores for substitution, demand and technological acceptability. A bioeconomic model is developed for estimating production, employment and foreign exchange effects in relation to small farm operations. Judging by one or more of these effects, about one-third of the countries could benefit from aquaculture. The importance and difficulty of economic analysis are emphasized.

Subject descriptors:
Economic development role; development planning; technology transfer; model.

191
Bond, B. J.; Madewell, Carl E.; Martin, John B.; Mays, David A.
1973.
T.V.A. projects--beneficial uses of waste heat.
Paper presented at National Conference on Complete WateReuse, Wash., D.C. April 23 to 27, 1973, 20 pp.
TVA projects show several ways in which the energy or heat discharged at condensers of powerplants can be used for agricultural and aquacultural development. The use of warm water heat exchangers to replace conventional greenhouse heating and cooling equipment, the use of warm water pumped thru raceways in catfish production, hot water use for heating livestock and poultry houses, and hot water use for recycling nutrients from livestock wastes are all discussed, and a few results from actual TVA experiments are given. The treatise on catfish production in warm water cites reasons why a new development like this is needed. Techniques and results of an experiment are outlined as well as the various problems involved which now prevent the new warm water system from commercialization. The authors also recognize managerial and environmental issues connected with adoption of the new plan. Results of the experiment did show that growth rates of catfish were significantly enhanced by the addition of heated water and that the growing season was significantly lengthened, though no data are given in the paper.
Subject descriptors:
Powerplant heat use; benefits; techniques.

192
Boozer, David.
1973.
Tropical fish farming.
Amer. Fish Farmer World Aquacult. News 4(8): 4-5.
Some of the tropical fish industry's problems include the adverse effect of the protein shortage, increasing feed costs, and some unfair selling and pricing policies within the industry. Sales of ornamental fish account for more than $200 million in retail sales in the United States. Some 20% of the fish are imported mainly from the Caribbean and South America. The rest is raised domestically. About 150,000 retail outlets sell tropical fish; a minimum of 20% of the over 7,000 pet shops deal exclusively in fish. Tropical fish represent the second largest hobby in the U.S. as 20 to 26 million households have aquariums. Approximately 500 million tropical fish are owned by households. A survey cited gives figures showing that the likelihood of having an aquarium increases with family size.
Subject descriptors:
Tropical fish; ornamental fish; general description; consumption data; survey data.

193
Brown, E. Evan.
1973.
Mariculture and aquaculture.
Food Tech. 27(12): 60-66.

This paper presents information on United States and Japanese aquaculture, including a brief discussion of species, prices, feed conversion, industry growth, and aquaculture's importance as a protein supplier. In Japan, the total harvest of cultured marine species increased by 742% from 1950, but the 1966 harvest amounted to less than 6% of Japan's total seafood sales. Freshwater fish culture in the United States is reviewed. For catfish, the three methods of production are explained (ponds, raceways, and cages) and data are given on the production percentages of each method.

Subject descriptors:
Japan; U.S; general description.

194
Cohee, Melville H.
1970.
Private outdoor recreation businesses: pond fishing enterprises.
Wis. Dep. Nat. Resour., Res. Rep 53, 32 pp.

Results of a sample survey of Wisconsin recreational, fee-fishing enterprises are reported. Some information is presented using two-way classifications. Among the items of information reported are size of ponds, participation days, season length, fish used (mostly trout), labor usage, gross income, factors influencing gross income, capital investment, planned investment, fees charged, and sources of information.

Subject descriptors:
Recreation; fee fishing; survey data.

195
Cowan, Dorian.
1971.
A specific legal perspective: Florida.
Thomas A. Gaucher, editor, Aquaculture: A New England Perspective. Univ. R.I., New Engl. Mar. Resour. Inform. Progr., pp. 57-70.

Although Florida was the first state to adopt laws authorizing aquaculture's use of the water column, legal problems were not fully appreciated at the time of adoption. Some of the problems encountered with the guidelines provided by the Florida State Cabinet under the 1969 statute are discussed. They relate to the effect of aquaculture on navigation, the adequacy of public access and navigational safety, the effect of aquaculture law and upland ownership, the need for stronger antipollution protection, the failure of aquaculture law to deal with conflicting interests, the inadequate provision for onshore installations, the State indecision about competitive bidding, and legal limi-

tations on aquaculture ventures. The actual guidelines in a fe
of the above areas are also given.
Subject descriptors:
Institutions; law; concepts; problems.

196
Culley, Dudley D., Jr.
1973.
Raceways; exotic species most affected by proposed E.P.A
discharge permits.
Amer. Fish Farmer World Aquacult. News 4(8): 9-12.
A proposed Environmental Protection Agency (EPA) ruling is quote
from the Environmental Reporter (May 4, 1973) pertaining to th
waste discharge by fish and other aquatic animal productio
facilities. The cited ruling specifically refers to raceways an
similar structures with continuous discharge, and to facilitie
containing nonnative species, regardless of continuity o
discharge flow. An exception is made for carp, goldfish, an
brown trout because of their relatively long U.S. residency tim
and widespread distribution. Alternative to obtaining Nationa
Pollutant Discharge Elimination System (NPDES) permits, thes
operations could build discharge holding structures (lagoons) o
treatment facilities (chemical and/or biological) and recirculat
the water. The problems with discharge of pollutants an
nonnative plants and animals are discussed. Except for raceway
and nonnative species, the proposed ruling is viewed as havin
little effect on aquaculture. Recirculation would conserve wate
and reduce nutrient losses in culture systems. Although cos
information is not provided, "(t)here is reason to believe tha
through increased efficiency of reclaiming wastes an
recirculating ... water the culturist can increase profits."
Subject descriptors:
Effluent guidelines; problems; evaluation.

197
Dassow, J. A.; Steinberg, M. A.
1973.
The technological basis for development of aquaculture to produc
low-cost food fish.
Mar. Fish. Rev. 35 (11): 6-13.
Future protein and fish demand, limited natural stocks, an
present concentration on the culture of high-valued species ar
the rationale for raising questions about the potential fo
low-cost food fish production via aquaculture. Know
high-productivity (output per acre) fish include freshwate
species with short food chains, but consumers have shown a highe
degree of preference for other fish. Recent developments in foo
technology have made high meat recovery (up to 45% to 65
compared to hand or machine filleting yields of 30% to 33%) an
control of flavor, texture, and stabilization practicable for th
output of frozen fish blocks, which in turn may be used t

produce items that have received consumer acceptance. Of course, technological problems require further work in developing a system for high-yield, low-cost cultured fish, and they relate to space (area or land), water (temperature, treatment), feeds and feeding (the largest cost item), mechanization of present labor-intensive activities, disease, efficient processing technology, pollution controls, and the development of markets and consumer acceptance.

Subject descriptors:
Processing; fish blocks; technology; development rationale.

198
Davidson, Jack R.
1972.
Economics of aquaculture development.
Proceedings, Fourth National Sea Grant Conference, Madison, Wis., Oct. 12 to 13, 1972. Univ. Wis. Sea Grant Communications Off., Sea Grant Publ. WIS-SG-72-112., pp. 75-83.

A perspective of the problems of aquaculture development and the role of economics are discussed. While the agriculture-aquaculture analogy is often cited, certain institutions have become established for agriculture, but not for aquaculture, namely tenure and use rights, credit, research, extension, and cost-price controls, many with government involvement. Economists can assist in the development process by providing analyses of institutions, demand, simulated costs and returns, capital budgets, and regional and local impacts. Early, cooperative interdisciplinary efforts to determine species selected, information needs and uses, etc., are suggested. A large, social R&D commitment (as to agriculture) is essential to aquaculture development.

Subject descriptors:
Institutions; problems; outlook; R&D role; public sector role; economic concepts.

199
Dobson, W. D.
1972.
Aquaculture: economic feasibility in the Great Lakes area.
Proceedings, Fourth National Sea Grant Conference, Univ. Wis., Oct. 12-13, 1972. Univ. Wis., Sea Grant Communications Off., Sea Grant Publ. WIS-SG-72-112, pp. 89-98.

Potential interest in aquaculture in the Great Lakes region is suggested on the basis of preliminary findings respecting both commercial food and recreational fishing. Processors and dealers formerly dependent on higher Great Lakes landings would provide a marketing medium, especially for such species as yellow perch, pike, and trout, but perhaps not catfish, except for certain areas. However, consumer and market preferences vary within the region. Lack of information dissemination, credit to start risky ventures, and a technology to provide warm water are among the

contraints to aquaculture development. Use of powerplant therma
effluent is in the promising experimental stage, with recognize
but hopefully manageable problems. Long-term market demand ma
be slow growing without promotion, because of relative (cite
income elasticities for fish and meat from warm-blooded animals.
Subject descriptors:
Great Lakes; development rationale; problems; outlook; economi
feasibilily.

200
Fedyaev, V. E.
1971.
Method of planning, recording and calculating the prime cost c
pond fish (O metodike planirovaniya, ucheta i kal'kulirovaniy
sebestoimosti prudovoi ryby).
Rybn. Khoz. 1971(12): 74-77. (Copy of translation available c
loan from NMFS.)
Methods of recording expenditures and calculating the productio
costs of pond fisheries are discussed. The processing method i
recommended. In the process of fish breeding there are stages o
phases, each with a marketable output. They are (1) breeding o
fingerlings, (2) breeding of underyearlings, (3) wintering, an
(4) fattening of the fish. For each phase the calculation fo
the fish bred and their marketable quantity should be prepared
How to calculate and record direct and indirect expenditures a
well as how to distinguish between production expenditures on th
output of commodities and those on unfinished products i
discussed and illustrated. What should constitute prime cost
for each stage of unfinished production is outlined.
Subject descriptors:
Methodology; economic concepts; Russia.

201
Fijan, N.
1971.
Present status and prospects of fish culture in Yugoslavia.
Proceedings, Symposium on New Ways of Freshwater Fisher
Intensification, Ceske Budejovice, September 22-24, 1971
Vodnany, Czech., Fish. Res. Inst., pp. 17-21.
The author reviews the history, current developments, and futur
prospects for fish farming in Yugoslavia. There are 20,00
hectares of carp ponds. Output doubled in 10 years to 20,00
metric tons of carp in 1970, with carp representing 89% of th
weight of cultured fish production. Also, 300 metric tons o
rainbow trout were produced. The use of pelleted feeds i
increasing. Chemical stimulation of carp ovulation, carp diseas
studies, preventive measures, and treatments are also discussed
(Based on ASFA abstract.)
Subject descriptors:
Yugoslavia; carp; trout; production data; history; outlook
biology.

202
Gates, J. M.
1972.
Appraising the feasibility of fish culture.
Economic aspects of fish production, International Symposium on Fisheries Economics, Paris, Nov. 29 to Dec. 3, 1971. O.E.C.D., pp. 327-348.
Biological and economic criteria are developed and applied to the selection of species for relatively large scale commercial aquaculture development and/or support by public agencies. The biological criteria include environmental adaptability and intensive culture adaptability (specifically, after Ryther and Bardach, 1968, reproduction in captivity, hardiness of eggs and larvae, easily satisfied food requirements, and growth speed). The economic criteria include market price and volume, potential interregional competition, competition from natural supplies, and the institutional or legal setting (regarding rights to water column or bottom, and environmental quality). By assigning numerical values to 6 of the criteria, 6 of 21 species or fish groups evaluated were selected for possible development and support in New England.
Subject descriptors:
Economic feasibility; biological feasibility; concepts; New England.

203
Gates, J. M.
1971.
Aquaculture in less developed countries: some economic considerations.
Preprints of 7th Annual Conference of Marine Technology Society, Wash., D. C., Aug. 16-17, 1971, pp. 579-583.
The benefits of aquacultural development, transforming traditional aquaculture (analogous T.W. Schultz's analysis of agriculture), and the public sector role in this transformation are discussed. Benefit-cost analysis is suggested, with special attention to factors that may affect benefits, such as supply-shift effects on price, current prices, potential market size and growth, and marketing efficiency and cost. The importance of market incentives, public R&D, use rights, credit, the relationship between urbanization and market system efficiency, and other factors are discussed. The public sector role relates to institutional aspects of rights, externality effects of new technology, research funding and direction, and the recognition of the importance of fish in the consumers' diets so far as R&D leadership are concerned.
Subject descriptors:
Economic development role; economic concepts; institutions; externalities; evaluation; public sector role; market role; R&D role.

204
Gates, John M.; Matthiessen, George C.
1971.
An economic perspective.
Thomas A. Gaucher, editor, Aquaculture: a New England perspective. Univ. R.I., New Engl. Mar. Resour. Inform. Progr., pp. 22-50.
Biotechnical and economic criteria are presented and applied for the selection of species with aquaculture potential. The biotechnical criteria include environmental and intensive culture adaptability (ability to reproduce, egg and larvae hardiness, nature of food requirements, and growth speed). The economic criteria include market price and volume, interregional competition, and competition from natural supplies. The market volume criterion requires application of income and price elasticities of demand to see if a minimum $1 million increase in sales volume could be absorbed within 10 years. Rejection under the sales volume criterion is intended to suggest low aggregate payoff, although individuals could find the species profitable to culture. Several species with possible potential are then accepted or rejected for aquaculture in New England according to these criteria, which are suitable for application to other areas.
Subject descriptors:
Economic feasibility; biological feasibility; concepts.

205
Gates, J. M.; Matthiessen, G. C.; Grisom, C. A.
1974.
Aquaculture in New England.
Univ. R.I., Mar. Tech. Rep. Ser. No. 18, 77 pp.
Topics include criteria for species selection, analysis of selected species, production costs, environmental and institutional considerations, summary and recommendations, and references. Biotechnical criteria include environmental adaptability (to New England condition), and cultural adaptability (reproduction ability in captivity, egg and larvae hardiness, easily satisfied food requirements, and rapid rate of growth, after Ryther and Bardach, 1968). Economic criteria include market volume and price, minimum sales volume, market demand, interregional competition and natural-supply competition. Five selected species, American oyster, hard clam, bay scallop, silver salmon, and American lobster are analysed respecting supply, demand, and state of the art (reproduction, larvae rearing, juvenile rearing, food, major technical problems, and culture in the natural environment). Production cost information is provided for salmon and lobster.
Subject descriptors:
Biological feasibility; economic feasibility; concepts; species selection; costs; New England.

206
Gaucher, Thomas A., editor.
1971.
Aquaculture: a New England perspective.
Univ. R.I., Narragansett, R.I., New Engl. Mar. Resour. Inform. Progr., 119 pp.
This publication is based on recommendations and several key documents from a conference to plan for aquaculture in northern New England (October 21-23, 1970, Durham, N. H.). Contents include: Conference recommendations, Donald B. Horton; A technological perspective, Thomas A. Gaucher; A general legal perspective, Harriet P. Henry; A specific legal perspective, Florida, Dorian Cowan; Hatchery design and operation information, Ronald D. Mayo; Useful references; and Conference notes.
Subject descriptors:
Technology; institutions; law; economics; biology; state of the art; New England.

207
Goodwin, Harold L.
1973.
Aquaculture in perspective.
Paper presented at the Sea Grant Association Meeting, Oct. 1973, U. S. Dep. Commer., Natl. Ocean. Atmos. Adm., Sea Grant Progr., 17 pp.
The United States has imported a substantial growing share of the fish consumed. Natural limits, growing world demand, and the consequent adverse effects on natural-stock fishing productivity and returns will make aquaculture an increasingly interesting alternative production medium. Yet, present world output from aquaculture is dominated by herbivores (carp, milkfish, and mullet), production is often labor intensive, the state of the art is often problem-ridden, U.S.-preferred species are not easily cultured, and utilization of U.S. industrial and economic development byproducts or wastes present legal, aesthetic, taste-preference, and institutional problems. If aquaculture is to develop, a holistic, interdisciplinary approach is required, and its case should not be overstated in terms of immediacy of returns and speed of development. NOAA's role via NMFS and Sea Grant is discussed, along with establishment of national goals, funding and other constraints, and requirements for project and research complementarity.
Subject descriptors:
Development rationale; outlook; research; R&D role; state of the art; problems.

208
Goodwin, Harold L.
1973.
The aquaculture state of the art: comments on problems an
progress.
Presented at FISH EXPO, New Orleans, La., Nov. 26,1973, 15 pp.
This paper explores the potential for aquacultural development
Overfishing for some natural fish stocks and underutilization o
others is discussed in light of the protein shortage
Underutilized stocks include squid, dogfish shark, and blu
mussels. Reasons for the shortage of protein are listed as wel
as reasons why aquaculture has not yet taken a strong foothold i
the United States to alleviate a worsening of the shortage in th
future. Some of them are: (1) slow technological advance an
adaptation to aquaculture, (2) environmental problems, (3) lac
of knowledge of economics and engineering of aquaculture, (4
ignorance of the biology of aquatic systems and inability t
control diseases on a large scale. Species listed and analyze
as to their potential for U.S. mass culturization include shrimp
oysters, lobsters, scallops, mussels, finfish, salmon, prawns
and herbivores. Net culture and ocean ranching are als
discussed.
Subject descriptors:
Development rationale; constraints; outlook; state of the art.

209
Griffin, Charles.
1970.
Loans for fish farmers and the types available.
Amer. Fish Farmer 1(5): 18-20.
Factors considered by the Lonoke County, Arkansas Productio
Credit Association (PCA), in granting credit are discusse
briefly, and a few comments on experiences with fish farmers ar
made. PCA's grant operating loans, with maturities of 1 year o
less, and intermediate term loans, with maturities of up to
years. The Lonoke County PCA has an annual loan volume (amoun
of loans granted) of about $30 million, with 20% to 25% i
fish-related business. Of those who began fish farming in th
early 1950's in the County, only 10% to 15% remain, but they hav
become successful and prosperous. Factors considered in grantin
credit are: (1) the man and his family, (2) financial positio
and progress, (3) repayment ability, (4) purpose of the loan, an
(5) collateral.
Subject descriptors:
Financing; credit; prospectus factors.

210
Hammack, Gloria M.
1971.
Bibliography of aquaculture.
Coastal Plains Cent. Mar. Dev. Serv., Wilmington, N.C., Publ. 71-4, 245 pp.

References and abstracts are given for 787 papers published in 1960-70, except for a few published in 1959. The three major divisions are related to marine and freshwater fishes, crustaceans, and mollusks, and each division has four subdivisions, which are general, biological factors, detrimental factors, and technical factors. Permuted-title and author indexes are included. The needs of the Coastal Plains Region were kept in mind when selecting entries from foreign countries. "While the basic orientation of the bibliography is to biological and technical factors, it will be useful not only to those involved in basic research, but also to beginning students, administrators, and fish farmers themselves." Entries by and of interest to economists are included but not in a separate subdivision.

Subject descriptors:
Bibliography.

211
Henry, Harriet P.
1971.
A general legal perspective.
Thomas A. Gaucher, editor, Aquaculture: a New England Perspective, Univ. R.I., New Engl. Mar. Resour. Inform. Progra., pp. 51-56.

The author discusses some of the laws and legal problems concerning aquaculture enterprises. State laws vary according to the State's historical, economic, and social heritage. Location of the enterprise (distance from shore) determines under whose jurisdiction it rests, i.e., whether it is State, Federal or international. High and low water marks as they pertain to State and private ownership of waters are discussed as are riparian owner rights, allocation of land, size of the area to be used for aquacultural activity and the time allowed for use, and the granting of the lease. Maryland, Virginia, and Rhode Island laws are discussed briefly. Other legal concerns include prohibition against allocating natural growing areas of shellfish for cultivation, State residency requirements for obtaining a lease, and effects of water pollution on the aquacultural enterprise.

Subject descriptors:
Legal barriers; institutions; concepts; problems.

212
Idyll, C. P.
1973.
Marine aquaculture: problems and prospects.
J. Fish. Res. Board of Can. 30(12, part 2): 2178-2183.
Aquaculture is expected to supplement, but not displace fishin
to have substantial, but inestimable potential output (say
least 10 times its present world output of 5 million metr
tons); and to be unable to supply low-cost protein to sol
protein-deficiency problems in the foreseeable future. Confusi
has occurred among four kinds of culture, relating to hatcheri
that supplement natural stocks (few such efforts have been prov
beneficial), use of wild stock young, use of eggs from wild-sto
parents, and use of cultured brood stocks. The relative
unaided rate of aquacultural development could be expedited
worldwide efforts to solve technical and engineering problem
Yet, "there are other constraints, legal, economic, and social
which are not tractable by research effort and they may be mo
significant. Research in several areas is discussed as follow
suitable species selection, nutrition and feeds, patholog
behavior, engineering, adverse effects of pollution, benefici
use of thermal and sewage effluents, legal constraints, economi
(e.g., feasibility and cost "bottleneck" evaluations), and soci
constraints (e.g., attitudes toward use of relatively expensi
shoreline property).
Subject descriptors:
Research; biology; benefits; constraints; problems; method
outlook.

213
Insull, A. D.; Richardson, I. D.
1971.
Economic assessment of marine fish farming development projects
Economic aspects of fish production, International Symposium
Fisheries Econ., Paris, Nov. 29 to Dec. 3, 1971, O.E.C.D., p
319-326.
This paper highlights some of the problems and considerations
appraising investment in marine fish farming. The demand f
cultured marine fish can be identified only in terms of present
preferred species, thereby limiting information on the eventu
size of the market or its species composition. Such factors
population size, increasing real incomes, price of product a
availability of competing protein foodstuffs, and the effect
marketing techniques are discussed as determinants of deman
Some techniques which have made mass rearing of mollusk seed
London, England, possible are touched upon as are the feasibili
trials of culturing plaice and sole in a Scottish loch enclosur
Among the conclusions reached are (1) that R&D on the culture
a mixture of species is needed to further expand the use
economic appraisal, (2) that R&D is needed before any econom
analysis or appraisals of fish farming can be attempted, (3) th
the amount of R&D resources required to reach objectives
development must be commensurate with possible returns a

benefits, (4) that governmental financing of fish farming would create new jobs, a new industry, and new export opportunities, and (5) that economic analysis is no more than a formal method of isolating judgement areas.
Subject descriptors:
Development rationale; concepts; economic development role; public sector role; R&D role; R&D evaluation.

214
Iversen, E. S.
1968.
Farming the edge of the sea.
London, Fishing News (Books), Ltd., 301 pp.
Listing of contents: general (why farm the sea?; sea farming, present and future), procedures, presently farmed species (seaweeds, oysters, clams and mussels, shrimps, milkfish, mullet, and miscellaneous pondfishes), potentially cultivable species, problems and evaluation (includes a glossary and an extensive list of selected references). This descriptive book is not a handbook or "how-to" book, but it does review important principles of sea farming. It attempts to help answer many of the questions asked increasingly of people at fishery laboratories, and it emphasizes biological aspects of sea farming. There is also emphasis on farming of the sea by developed nations in temperate and subtropical waters of the Northern Hemisphere. Significant differences may be expected in tropical waters and developing countries.
Subject descriptors:
Methods; techniques; state of the art; problems; research; biology; bibliography.

215
Johnston, Warren E.; Collinsworth, Don W.
1973.
An annotated bibliography for economic evaluations of the aquaculture of selected crustaceans and mollusks.
Univ. Calif., La Jolla, Calif., UC-IMR Ref. No. 74-3, Sea Grant Publ. No. 2, 26 pp.
A selected, preliminary bibilography with the following major headings: bibliographies (general aquaculture and specific species), abstracts and indexes, statistical sources (FAO, U.S. Government, States, other), aquaculture (general and descriptive, and specific species), natural fisheries and fisheries with potential for aquaculture (general and descriptive, and specific species), marketing (general market demand for specific species, other marketing), and author index. Many of the economic items annotated provide information related primarily to the supply, demand, and economics of wild-stock fish. This kind of information is directly useful in evaluating aquaculture where markets, product forms, and economic activities (such as processing and distribution) are the same or similar for

wild-stock and cultured fish, and it is also useful i understanding the degree of competition between the two source of supply.
Subject descriptors:
Bibliography; economics; crustaceans; mollusks.

216
Jones, A.
1972.
Marine fish farming: an examination of the factors to b considered in the choice of species.
U. K. Min. Agri. Fish. Food Lab., Leafl. (New Ser.) 24, 16 pp.
In the absence of established U.K. commercial operations fro which revenue, cost, and return data might be obtained, ar attempt at an assessment of the economic feasibility of marir fish farming must be rather speculative. Yet, it is useful t examine some of the possible production costs for guidance as t which species are most likely to provide positive returns. Iten of cost are listed in the leaflet and costs estimated for labor tanks, juvenile stock, and feed, with 10% added for overheac repairs, and clerical expenses. Various prevailing technical ar economic factors affect the assessment and judgement on specie ranking at any point in time, but it now appears that effor should be concentrated on the R&D for high-priced species in th United Kingdom, such as turbot, dover sole, hake, and halibut but not red sea bream and plaice. (Based on ASFA abstract.)
Subject descriptors:
United Kingdom; outlook; evaluation; concepts.

217
Jones, Walter.
1970.
Commercial fish farming; how to get started.
Amer. Fish Farm. World Aquacult. News 1 (2): 5-8. Reprinted 1972, 4 (1): 10-13, 19.
This article presents a checklist of items to consider befor investing any sizeable sum in a fish-farming endeavor. Among t items are information sources, economics, management, marketin physical features of the production complex, source fingerlings, feeding, harvesting, transporting, and marketing.
Subject descriptors:
Prospectus factors; risks.

218
Joyner, Timothy; Richards, Jack A.; Tanonaka, George K.
1971.
Improving productivity of Washington's water resources throu aquaculture.
U.S. Dep. Commer., Natl. Mar. Fish. Serv., NW. Fish. Cent unpubl. manuscr., 27 pp.
Topics include: market demand growth for salmon and so

shellfish, the potential for sea farming in Washington, the potential economic impact, and institutional constraints. U. S. past and projected consumption, production, and import trends are discussed. Washington resources, adverse fishery changes (pollution and development related), and recent aquaculture developments are discussed, along with the technical requirements for several culture systems (feedlots, grazing, hatcheries). The authors provide estimates of the net inflow of money payments to Washington State from three kinds of culture operations and developments. The discussion of institutions centers around property rights, ownership and control, and the necessity of sufficiently long tenure to assure investment. The mariculture medium, the coastal "water column" and sea floor, is viewed as a common property natural resource.
Subject descriptors:
Benefits; demand; development rationale; benefit-cost analysis; evaluation.

219
Joyner, Timothy; Safsten, C. Gunnar.
1971.
Prospects for sea farming in Pacific Northwest.
Mar. Fish. Rev. 33(9): 22-26.
Mariculture may have many benefits, including an economic incentive to control despoilment of coastal waters by other industrial and urban activities. Specific attention is given to the Puget Sound area of the Pacific Northwest. Mariculture systems (feedlots, grazing, and hatcheries) and their products are explained. Products include salmon, oysters, prawns, and seaweeds. The state of the art, stage of development, research, and the commercial feasibility outlook for these products are discussed.
Subject descriptors:
Benefits; methods; development stage.

220
Kildow, Judith; Huguenin, John E.
1974.
Problems and potentials of recycling wastes for aquaculture.
Mass. Inst. Tech., Sea Grant Rep. No. MITSG 74-27, 170 pp.
Contents include the use of thermal and domestic sewage effluent in marine aquaculture, related problems and advantages, and social, legal, political, and economic factors in marine waste-food recycling systems. Legal aspects, consumer acceptance, and marketing strategies are discussed in detail to indicate that care must be taken to avoid past errors and possible problems. Appendices contain references, a decision making model, proposed EPA rules, pilot consumer survey results, and other information.
Subject descriptors:
Power plant heat use; sewage effluent use.

221
Krupauer, V.
1971.
Czechoslovak fishery and piscicultural research.
Proceedings, Symposium on New Ways of Freshwater Fisher Intensification, Ceske Budejovice, Sept. 22-24, 1971. Vodnany Czech., Fish. Res. Inst., pp. 110-124.
The history of Czech pond fish culture is briefly outlined. Mos fish ponds are now subject to standardized fish-farming methods In the last 25 years fish production has increased threefold, an duck breeding, introduced 20 years ago, now accounts for 7,80 metric tons of output annually. Growth and success ar attributed to: (1) national interest in fish and fowl breeding which is regulated by grants, and price and marketing policies and (2) creation of the State Fishery, which manages 78% of th Czech fish ponds. Supplementary feeding is not significant. Th production season lasts 5 months and total annual output of fis and poultry averages 460 kg/ha. While river and lake fishing i considerable, pisciculture in the waters is endangered b pollution. Other problems include breeding, feeding, an cultural methods. (Based on ASFA abstract.)
Subject descriptors:
Czechoslovakia; history; production data; problems.

222
Lampe, Harlan C.; Marshall, Nelson; Sutinen, Jon G.; Vidaeus Lars O.; Westin, Deborah T.
1974
Prospects for fisheries development assistance.
Univ. R. I., Mar. Tech. Rep. Ser. No. 19, 41 pp.
The potential of aquaculture and capture fisheries in developin countries is examined and assessed with a global view in relatio to development assistance. In their assessment the author provide supportive information on forecast fish demand (to th year 2000), relative costs of fish and other protein (i.e. estimated producer prices expressed in U.S. dollars per kilogra of protein) in various countries, comparisons of aquacultura enterprises (e.g., yields or economic gains; revenue, cost an return statements), and other factors.
Subject descriptors:
Economic development role; world; demand analysis.

223
Landis, Robert C.
1971.
A technology assessment methodology: mariculture (sea farming).
Mitre Corp., contract No. 26, project No. 1310 for Ex. Office o the President, Office Sci. Tech. Assessment, MTR-6009, vol. 5 180 pp.
A general technology assessment methodology is used to determin the impacts of mariculture on the developing countries. Th

technology is confined to application in coastal and brackish waters. A quantitative impact analysis of economic and social factors is shown for the years 1975-1989. Various action options are posed. The problems and constraints to accelerated mariculture application are analysed, and a forecast of 20 million tons of mariculture production in 1985 is made.
Subject descriptors:
Methodology; model; forecasts; evaluation; economic development role.

224
MacCrimmon, H. R.; Stewart, J. E.; Brett, J. R.
1974
Aquaculture in Canada--the practice and promise.
Bull. Fish. Res. Board Can. No. 188, 84 pp.
Some forms of aquaculture have existed in Canada for many years on a small scale. This Bulletin reviews the current practices and identifies opportunities for establishing a substantial and viable industry based upon freshwater fisheries, marine fishes, and invertebrates. It focuses on the scientific and technical basis for such an industry and on the constraints to be encountered, and identifies areas that need experimental development to provide pilot-scale production data and economic assessments. (Authors' abstract. See G. I. Pritchard for comments relating to the same seminar where the authors originally presented their work.)
Subject descriptors:
Canada; outlook; constraints; general description.

225
Milne, P. H.
1973.
Development of fish farms in Japan.
Fishing News Internatl. 12(12): 17-20, 23-24.
Japanese aquaculture output grew from 94 kilotons in 1951 to 340 kilotons in 1961 and to 608 kilotons in 1971 when it accounted for 6.7% of the total fish catch. Seaweeds accounted for half of the 1971 weight of output, and oysters, 200 kilotons, with the remainder consisting of yellowtail, prawn, sea bream, abalone, and octopus. Government assistance of various sorts is provided to the 29,000 fishermen involved (out of total of 550,000 in Japan). Additional information is provided on the several species.
Subject descriptors:
Japan; production data; government assistance.

226
Moore, J. Jamison.
1970.
The ocean--an economic perspective.
Mar. Tech. Soc. J. 4(6): 33-37.
The results of three surveys of ocean-oriented industries and activities (1963, 1966, and 1969) are discussed and used to estimate past and future investment growth. Limitations and problems are discussed. Estimated annual expenditures are $7.9 billion. The total investment (capital or asset level) is $165.2 billion (1968-69), and it is estimated to increase 47% by 1980 and threefold by 2000. Coastal zone capital will increase at a faster rate, 76% by 1980. Aquaculture investment is included in one of four resource categories without a separate amount, and petroleum is the most important among these four categories. Rapid coastal zone growth (where aquaculture development is expected to occur) will bring problems of management (competing, compatible, and low- and high-density uses).
Subject descriptors:
Investment; forecasts; outlook; survey data.

227
Nash, Colin.
1972.
Marine fish farming development.
Proceedings, Kauai Aquaculture Conference, Lihue, Kauai, June 25, 1972, pp. 22-28.
Under three headings (general considerations, economic and technical factors, and conclusions), recommendations of possible finfish species for Hawaiian aquaculture are made. The following economic and technical factors are considered, with supportive discussion and both input-output and price range estimates where appropriate: local environmental advantages and disadvantages, juvenile availability, costs of suitable food and labor, growth time to market size, original stock survival, commercial value (price), and cost of facilities. It is concluded that Hawaii has certain limitations respecting the culture of finfish, such as limited markets, feeds for carnivores, and suitable offshore topography. Yet, the water quality is high and technical expertise is available. The tropical or semitropical carnivores, dolphin (mahimahi), and grouper are suggested for consideration, along with the herbivores or omnivores, mullet, and rabbitfish species. Even so, cultural methods specific to these fish are not ready for use, and the prospects for immediate commercial culture are consequently not good. Yet, it is believed that investment in R&D and pilot operations, if carefully made, will payoff.
Subject descriptors:
Hawaii; species selection; outlook; development rationale; problems.

228
Neal, R. A.
1973.
Alternatives in aquacultural development: consideration of extensive versus intensive methods.
J. Fish. Res. Board Can. 30(12, part 2): pp. 2218-2222.

This paper briefly compares legal, biological, economic, environmental, and social aspects of intensive and extensive animal aquaculture. While commercial choices and feasibility are ultimately matters of economics, research is being planned on the basis of available general information and insufficient specific data. It is concluded that intensive culture is more likely to become feasible for most carnivores and omnivores, and extensive culture (culture with few modifications of the environment), only for a few herbivores (such as oysters, mussels and milkfish). Most species of interest fall into the intensive culture category, and research is being planned accordingly. Biological factors considered (non-interactively) are feeding, environmental control, disease and density; economic factors include facility costs, competing uses of natural water, operational costs (related to biological factors), and reliability (risks).

Subject descriptors:
Research; species selection; problems.

229
Odum, William E.
1973.
The potential of pollutants to adversely affect aquaculture.
Proceedings, 25th Annual Session, Gulf and Caribbean Fisheries Institute, Miami, Fla., Nov. 1972, pp. 163-174.

The potential of pollutants to act as limiting factors on aquaculture is discussed, with reference to organic wastes, industrial wastes, power plant effluents, and large-scale environment modifications. Documented cases of damage are few. Intensive (closed) culture affords better control than extensive (open) culture. Deleterious effects of organic wastes manifest themselves indirectly. Minamata Bay, Japan, industrial waste (mercury) consequences are cited. Petroleum products can affect survival, growth, and taste, depending on concentration. Pesticides from feed, water runoff, and other sources are a problem. While bioaccumulation of isotopes from nuclear powerplants is discounted as a danger, copper and chlorine may be serious contaminants in powerplant aquaculture.

Subject descriptors:
Pollutants; biology; research; problems; outlook.

230
Okolo-Kulak, S.
1970.
Sea fisheries and agriculture: comparison of two fields o economy (Rybolowstwo morskie an rolnictwo-porownani miedzygaleziowe).
Tech. Gosp. Morska 20(2): 63-65. (Copy of translation availabl on loan from NMFS.)
While the author does not discuss aquaculture per se, som differences between and similarities of sea fisheries an agriculture are discussed with particular emphasis on the method and tools of comparison. Among the differences are: (1 geographical placement of fisheries reach far beyond nationa boundaries and enlarges the country's territorial food base, (2 decreasing returns appear in all cases where arable land an fishing banks are constant and the remaining production factor increase successively, though less in fisheries than farms, (3 no capital expenditures occur for fish production base, (4 structure of fixed assets and variety of farm produce differ The main similarity is the close connection of productiv activity and nature and the accompanying risks. Weighin products, wages in the two fields, scope of the comparison assumption of certain operating conditions and circumstances i both branches, selection of reference units to calculate indexes and proper interpretation of results are among the items include in a discussion of methodological problems and procedure pertaining to comparison.
Subject descriptors:
Economic concepts; methodology; agriculture; ocean fisheries Poland.

231
Owens, Gerald P.
1964.
Income potential from outdoor recreation enterprises in rura areas in Ohio.
Ohio Agri. Exp. Sta., Res. Bull. 964, 51 pp.
Fishing and pay-lake operations are included in the report. Th purposes of the study were to provide information on the numbe of recreational enterprises in the unglaciated area o southeastern Ohio, and to provide data on land, labor, an capital requirements; costs and income; operator characteristics and management and technical problems for seven of the mor popular types of rural enterprises commonly provided via privat capital. A sample of 31 enterprises (5 pay lakes) was selecte from an estimated population of over 250 firms in a 23-count area, and the financial data are for 1961. Catfish, bass, an bluegills are the most popular stocked fish, but some lakes als stock other species. Itemized capital investment, income an expenses, net cash income, and returns to family labor an management for the five paylake operations are shown (average an range data for all items). Numerous factors are analysed usin

tables and text in the section on comparative analysis of recreational enterprises (pp. 24-45), and a shorter section is devoted to factors to consider in establishing or changing an enterprise.
Subject descriptors:
Recreation; fee fishing; survey data; revenue; costs; returns; sccio-economic data.

232
Palfreman, D. A.
1973.
The economics of marine fish farming.
Fish Farming Internatl. 1(1): 47-52.
Preliminary economic analyses have been made by the British White Fish Authority. The basic objectives and methodological considerations are described briefly. The purpose is to guide R & D to cost-critical areas, so only partial cost estimates are made, disregarding non-critical aspects of cost.
Subject descriptors:
Economic concepts; methodology; evaluation.

233
Palmer, H. V. R., Jr.
1974.
Biologist finds sewage, aquaculture compatible.
Natl. Fisherman, 55(2): 12-B.
Progress is described in the experimental development of a system to produce clean water from secondarily-treated sewage and to provide food for shellfish and finfish under culture conditions. This concerns work by Dr. John Ryther, marine biologist, Woods Hole Oceanographic Institution, Mass. An expanded operation was begun in fall, 1973, with 6 ponds (each holding 36,000 gal. seawater-sewage mixture containing about 2/3 sewage), capacity of 100,000 gal. sewage per day, algal output of equivalent volume, and capability of serving a city of about 500,000 people. The experimental system is of interest to sanitary engineers for tertiary sewage treatment. Oysters and quahogs feed on the algae, and abalone feed on Irish moss. The algae and moss depend in turn on the nutrients in the sewage-seawater mixture. Seaworms (Capitella) and bait worms (Nereis) feed on the oyster and quahog droppings, respectively, and serve as feed for finfish. Viruses from the sewage are an obstacle, but the system can also be operated using commercial fertilizers as a nutrient medium in place of sewage.
Subject descriptors:
Sewage effluent use; experiment; techniques; state of the art; mollusks; finfish.

234
Pillay, T. V. R.
1972.
Coastal aquaculture in the Indo-Pacific region.
Fishing News (Books), Ltd., 497 pp.
Papers and/or abstracts presented at the Indo-Pacific Fisherie Council Symposium on Coastal Aquaculture, Bangkok, Thailand, Nov 18-21, 1970, are organized into eight sections. Sections on (region and country reports), four and five (techniques), an eight (economics) contain information of particular interest t economists, such as area and scope, manpower, yield an production, source of seed, culture management, costs an returns, and problems. Costs and returns for culture operation of various kinds in Taiwan, Japan, Korea, Malaysia, and Thailan are reported (pp. 13-15, 35-81, 310, 314, 351, and 490-7)
Subject descriptors:
Asia; costs; returns; general description; problems; biology.

235
Pillay, T. V. R.
1973.
The role of aquaculture in fishery development and management.
J. Fish. Res. Board Can. 30(12, part 2): 2202-2217.
Contents include present status, role in fishery development role in fishery management, and potential. Present worl production is estimated as about 5 million metric tons Estimates for 2000 range from 15 to 50 million metric tons Usage of low-grade fish, waste and sewage-fed ponds, employment rural development, and other subjects are discussed. Appendi tables give production by country, and cost information fo aquaculture operations in various countries: trout (Irelan and Norway), carp (Poland and India), grey mullet and Chin carp (Hong Kong), milkfish (Philippines), yellowtail (Japan) catfish (United States), shrimp (Japan and Thailand), an oysters (Japan).
Subject descriptors:
World; production data; state of the art; development stage revenue; costs; returns.

236
Pinchuk, V. A.
1970.
Economico-mathematical model for optimum exploitation of fish culture production resources (Ob odnoi ekonomiko-matematichesk modeli optimal'nogo ispolzovaniya proizvodstvennykh resurs rybovodstva).
Rybn. Khoz. 1970(11): 118-122. (Copy of translation available loan from NMFS.)
The purpose of this paper is to present an example of the use linear programing for the optimization of exploitation of fis culture production resources in the Donetsk fishery group. T

model illustrated attempts to discover means for economizing on expenditures while maintaining the actual output volume of each district within the Donetsk area. In Donetsk, the 1968 fishery output was 26,268 centners of food fish and 3,533 centners of fingerlings; prices were 90 to 120 rubles and 120 rubles per centner, respectively. (One centner = 100 kg, also called a quintal.) The model's objective function, constraints, and related computational formulas are given. Tables of actual, optimized, and saved (according to the model) input usage are given for eight production districts of the Donetsk fishery group, with itemized data for feeds, fertilizers, labor, fingerlings, electric power, and pond area.
Subject descriptors:
Economic concepts; methodology; input-output data; firm data; Russia.

237
Prewitt, Roy.
1971.
Rambling along.
Amer. Fish Farmer World Aquacult. News 2(12): 17-18.
In relation to expected Corps of Engineers requirements that fish farmers obtain effluent discharge permits, a concern is whether or not fish farmers would be eligible to receive Department of Agriculture cost-sharing assistance for relevant conservation practices. Several precedents are cited to argue that fish farming has been viewed as an agricultural or farming activity and should therefore be eligible for this cost-sharing assistance.
Subject descriptors:
Conservation; effluent guidelines; legal barriers; government assistance; cost-sharing.

238
Prewitt, Roy.
1972.
Rambling along.
Amer. Fish Farmer World Aquacult. News 3(7): 16-19.
Legal barriers to the development of aquaculture, their removal, especially in Arkansas, and fish farming investment, revenue, and returns are discussed briefly. Beneficial aspects of fish farming are reviewed briefly using data for all or parts of Lonoke County, Ark. New jobs have been created, youth interest stimulated, and soil and water conservation practices promoted. Capital investment has totaled about $833 per acre ($208, ponds and water supply; $400, land; other, $225; total, $833). Production Credit Association loans total about $6 million and are increasing at about $1 million annually. Data on other financial sources are not readily available. Net returns per acre are indicated for soybeans, rice, cotton, and several fish crops.
Subject descriptors:
Legal barriers; benefits; returns.

239
Pritchard, G. I.
1973.
Constraints to aquacultural development.
Canadian Fisherman and Ocean Science 59(4): 22-27.
Several Canadian constraints are discussed: development costs, feedstuffs, risks, habitat, seed stock, monoculture and government policies. The complexity of aquaculture systems requires high R&D and lead (viability testing) time in excess of the 2 to 3 years industrial managers are usually willing to accept. Aquaculture is essentially a feed-lot operation that converts, but does not produce food. Low-cost food supplies are essential. Risks (disease, predator, storm, and market uncertainties) may limit fish feed-lot size and require dispersion. Habitat problems range from site selection and climatic zone limitations to protection. Seed stocks represent an important cost, following feed and labor; hatcheries afford genetic and health control, but also call for different culture and management than grow-out stages. Mono and multiculture systems and government policies present questions and problems.
Subject descriptors:
Canada; constraints; concepts.

240
Pritchard, G. I.
1973.
With the decline of natural fish stocks other sources must be used.
West. Fish. 86(4): 38-43.
The author discusses the future of aquaculture in Canada and the need for it to be market oriented and competitive. More than 300 private trout hatcheries exist in Canada as a result of demand for fry and fingerlings for planting in private lakes and recreational ponds. Government-sponsored and operated hatcheries produce annually more than 1 million pounds of fry, fingerlings, or smolts for public waters. Constraints to aquacultural development in Canada are discussed. They include underestimation of the project scale needed to cover costs, the lack of low-cost feed for fish, and the unwillingness of producers to bear the risk burdens inherent in aquacultural development.
Subject descriptors:
Canada; outlook; problems; constraints.

241
Richards, Jack; Tanonaka, George.
1971.
Mariculture in the United States.
U.S. Dep. Commer. Natl. Mar. Fish. Serv., NW Fish. Cent., unpubl. manuscr., 9 pp.
U.S. interest, national policy, and the NOAA role in policy implementation are discussed. Increasing U.S. dependence on

imports, increased world product-market and resource (fishery) competition among fishing nations and consequent rising prices, jurisdictional problems, mariculture's efficient use of space, and other reasons are cited to explain U.S. interest in mariculture. As to national policy, market demand should essentially determine what is produced and production-efficiency R&D choices. Institutional arrangements require various actions at several levels. The NOAA role in policy implementation would appear to lie in initial R&D, information transfer, continued supportive research, and leadership.
Subject descriptors:
Outlook; development rationale; institutions; demand; R&D role; public sector role; market role.

242
Rouzaud, Pierre.
1973.
General situation of aquaculture in France.
Brackishwater Aquaculture in the Mediterranean Region, FAO, General Fisheries Council for the Mediterranean, Stud. Rev. (52): 25-33.
Private and public sector research and experimental commercial activity are described (to 1971), and proposed work is indicated. One firm is operating a commercial eel farm, using juveniles obtained from natural stocks. Research relates to reproduction, feeds and feeding, growth and other cultural study areas for bass and gilthead bream, turbot, shrimp, Pacific salmon, trout in sea water, and mullet.
Subject descriptors:
France; research; experiments; state of the art.

243
Rutka, Justin.
1969.
Evolution of public policies affecting exclusive use of coastal zone fishery resources: a comparison of public policies of Japan and the United States with implications on the status and potential of aquaculture in Hawaii.
Univ. Hawaii, Dep. Agri. Econ., unpubl. paper, 27 pp.
The author compares definitions of aquaculture, food output from land and ocean resources, distribution and intensity patterns, agricultural and aquacultural yields (which are rejected as comparisons since they refer to only one input and are therefore without much meaning), and the importance of aquaculture in Japan and the United States. Then the legal history of use and ownership patterns of tidal lands are explored briefly for the United States, Japan, and Hawaii. Owing to its shortage of arable land and dependence on the sea, Japan developed institutions of exclusive use and formalized them into law in the Meiji Restoration of 1848. In 1949, "demarcation rights" were established for shallow sea culture. The U.S. system derives

from the English common law system, with private property and public-trust or common rights, the latter applying to submerged coastal lands and tidelands. Presumptions of ownership, Federal-State conflicts, and court cases ensued. The Hawaiian system was closer to that of Japan until the U.S. Congress manifested its intent to preclude private fishing rights in the territorial legislation of 1900, except for ponds or artificially enclosed areas. Again, court cases ensued and the situation is uncertain, thereby serving as a disincentive to investment in aquaculture.
Subject descriptors:
Institutions; Japan; Hawaii; U.S.; constraints; history; legal barriers.

244
Ryther, John H.; Bradach, John E.
1968.
The status and potential of aquaculture, parts 1, 2 and 3.
Clearinghouse Fed. Sci. Tech. Inform., 531 pp. (The publisher supplies vol. 1, containing parts 1 and 2 as PB 177 767, and vol. 2, containing parts 1 and 3 as PB 177 768.)
Part 1 includes introduction, general principles, conclusions, summary and recommendations; part 2, shellfish; part 3, finfish. While it was not possible for the authors to conduct an exhaustive survey of aquacultural practices for the world, they did select examples which are representative of as many as possible of the different species of organisms in culture, the different countries or regions of the world with respect to climate, race, and economic development where aquaculture is carried out, and the different levels of intensity and technological sophistication which are in use and may be included within the broad definition of aquaculture. For each example, as much information as possible has been obtained on the basic biology and ecology of the organism in culture, the procedures and techniques employed in the practice, and yields and economics of the operation, if commercial. (Authors' statement modified.)
Subject descriptors:
State of the art; world; research; methods; techniques.

245
San Feliu, J. M.
1973.
Present state of aquaculture in the Mediterranean and Sout
Atlantic coasts of Spain.
Brackishwater Aquaculture in the Mediterranean Region, FAO, General Fisheries Council for the Mediterranean, Stud. Rev. (52):
1-24.
Based on information gathered in a survey-tour, production volum and value, input data (area, rafts, lines, etc.), techniques an other description are provided for commercial aquaculture, wit annual data for one or more production seasons in the perio

1967-71. Government research center activity is indicated. Expansion, intensification, and diversification possibilities are given, along with indications of the restrictions caused by increased harbor traffic in some culture-site areas and agricultural pollutants in others. The Spanish coastline consists largely of beaches and rocky cliffs, reducing the amount of area suitable for culture. Commercial culture species include mussels (grown on specially constructed rafts, called "bateas"), flat oysters (but the northwest Spanish coast has more commercial activity), Portugese oysters, and in confined coastal waters, eels, elvers, bass, gilthead bream, carp, goldfish and other species. Mollusk cleansing (purification) plants are also described.
Subject descriptors:
Spain; survey data; general description; mussels; oysters; eels; bass; gilthead bream; carp; goldfish; depuration plants.

246
Sarig, S.
1972.
Fisheries and fish culture in Israel in 1971.
Bamidgeh 24 (3): 55-75.
This article contains graphs, tables, and other data on fisheries and fish culture in Israel in 1971. Total catch rose by 5,000 metric tons compared to 1969, a 24% increase. Fish culture accounted for 50% of the increase. Compared to 1970, the 1971 catch increased by 3,100 tons (13.5%), of which fish culture was responsible for 21%. Per capita consumption in 1969-71 according to sources and use is given in table form. Data on marine fisheries, the inland fishery (Lake Kinerith), and the canning industry are also graphed, tabled, and summarized. The section on fish culture includes data on fish pond area and yields (1963-71), and average annual yields of marketable fish by regions (1969-71) and by productivity groups. A section on fish species cultivated in ponds reveals that mullet decreased by 24% compared to 1971. Marketing of the pond fishes is discussed and tabled by month from 1968 to 1971. The average national yield of pondfish increased by 3.2% compared to 1970.
Subject descriptors:
Production data; consumption data; acreage data; productivity; markets.

247
Sarig, S.
1973.
Fisheries and fish culture in Israel in 1972.
Bamidgeh 25(2): 35-55.
This article contains graphs, tables, and other statistical data on fisheries and fish culture in Israel in 1972. Total Israeli fishery catch for that year was 26,741 tons, which represented a 3.3% increment over 1971. There has been a 30% increase (3,016

tons) in pond culture since 1970. Pond culture catch is 50% of the total Israeli catch. Graphs show the distribution of fish pond catch by year and total catch by year and source. Data on catch by species, source, and percentage increases in catch are given for the 1960's and through 1972. The number of fish farms decreased by 2.4% in 1972. The cultured species discussed are carp, tilapia, mullet, and silver carp. The increment in 1972, compared to 1971, of cultured carp was 400 tons (3%) and for tilapia it was 132 tons (12%). Cultured mullet decreased by 55 tons (6%). Ton amounts, increases, and decreases in marketed pondfish from 1969 to 1972 are illustrated graphically and in table form. The portions of carp, tilapia, mullet, and silver carp in all pondfish marketed amounted to 84.7%, 9.2%, 4.2%, and 1.9%, respectively. A summary of major points is also given.
Subject descriptors:
Israel; production data; consumption data; acreage data; productivity.

248
Scott, Anthony.
1970.
Economic obstacles to marine development.
William J. McNeil, editor, Marine aquiculture, Selected papers from Conference on Marine Aquaculture, Oreg. State Univ., Mar. Sci. Cent., Oreg. State Univ. Press, pp. 153-167.
Topics related to aquaculture include: control over resources, demand, research, and innovation, and property, tenure and externalities (exclusion and spillover, permanence and flexibility). Markets for aquacultural products now relate either to luxury or to cost-advantage items. It is suggested that R&D proposals be submitted to more rigorous evaluation as to economic payoff. Innovation (the actual implementation of methods determined in the R&D process) in the fishing industry is as likely as in other industries, but the business operators are properly skeptical, given the risks of their ventures and their interest in payoff. Natural resource use and development require exclusiveness (to assure returns and for protection from adverse spillovers of other activities), permanence (to secure returns which accrue through time) and flexibility (to allow changes in technique without penalties).
Subject descriptors:
Economic concepts; institutions; R&D role; R&D evaluation; risks.

249
Secretan, P. A. D.
1975.
Insurance for fish farmers.
Fish Farming Internatl. 2 (1, 2, 3): 26 and 28, 22-23, 26-27.
Three aspects of insurance for fish farmers are discussed: stock losses, inflation protection, and risk management. Insurance is viewed as a device for handling major losses, but the

accumulative effect of numerous small losses must also be recognized in a risk management program. Several suggestions are made to achieve risk reduction and a satisfactory insurance program. Good records to establish loss values, loss-preventive action, loss-mitigative action, large deductibles, timely adjustment of coverage in inflationary periods, and risk management analysis are among the factors considered.
Subject descriptors:
Insurance; risks; general description.

250
Shang, Yung C.
1973.
Comparison of the economic potential of aquaculture, land animal husbandry and ocean fisheries: the case of Taiwan.
Aquaculture 2(4): 187-195.
The comparison is based on productivity, cost, internal rate of return (IRR), Taiwanese consumer demand, expected growth, and nutritional information and analyses. Taiwanese aquaculture includes brackish water (milkfish), freshwater (carps and tilapia) and shallow sea (mostly oysters) production. Ocean fisheries are divided into deep-sea (mostly tuna and tunalike species for export), inshore, and coastal fisheries categories. Hog raising is the most important and well established form of land animal husbandry. At present, the IRR's for all culture methods exceed those for ocean fisheries and hog farming. With some government and industry development programs, culture technology and management are expected to improve, allowing for lower costs, whereas ocean fishery costs are not expected to change (given the present advanced state of technology). In terms of calorie and protein content, protein cost, quality, and consumer preference comparisons, fish culture seems to have a distinct advantage in Taiwan. Labor productivity (kilograms of output per man year), geographic productivity (kilograms per hectare), and average costs of output (U.S. $ per kilogram) may result in different rankings than the IRR criterion. Data for some of these variables are given for both average and superior management conditions.
Subject descriptors:
Taiwan; enterprise comparison; costs; returns; productivity; consumption data; demand; supply; outlook.

251
Smith, Leah J.; Huguenin, John E.
1975.
The economics of waste water--aquaculture systems.
1975 IEEE [Institute of Electrical and Electronics Engineers] Conference Record on Engineering in the Ocean Environment, Ocean '75, September 22-25, 1975, pp. 285-293.
Based on a system developed at Woods Hole Ocenaographic Institution, the "design, performance, and resulting costs of

operational systems for commercial production scaled up by factors of 10, 100, and 1000 are projected and compared. Despite uncertainties in the systems, our analysis shows that large-scale systems using sewage as a nutrient source and free heat from power plant effluent (or located in a warm climate) could be profitable."

Subject descriptors:
Power plant heat use; sewage effluent use; costs.

252
Sysoev, N. P.
1970.
Economics of the Soviet fishing industry (Ekonomika rybnoi promyshlennosti SSSR).
D. Daneman, transl., Israel Progr. for Sci. Transl., Jerusalem, 1974, 386 pp. (Obtain from NTIS.)

This book is approved by the U.S.S.R. Ministry of Fisheries as a textbook for institutions of higher learning, and describes the fishing industry, its development, management, and analysis in economic terms. Capital investment, enterprise cost, profit, labor productivity, price formation, financing, and other concepts are explained. While pond fish culture is not identified as a separate topic in the table of contents (there is no index), it is discussed. (See e.g., pp. 30, 46, 101-105, and 225.) Pond fish have accounted for 0.6% of the U.S.S.R. catch for 30 years, with their output increasing from 8.4 (in 1940) to 52.4 (in 1968) metric kilotons. Productivity averaged 0.67 tons/ha in 1968. Economic indicators are shown for six advanced farms in 1968, and include output in tons per hectare, prime cost per ton, profit per ton, profit as a percent of prime cost, profit as a percent of fixed assets, and normal working capital (10 to 30%), and time to recover asset investment (3-8 years). Carp account for up to 90% of the warmwater output. Herbivores accounted for 11% of total pond output in 1968. Profit and productivity improvements relate to mechanization, mineral (nonorganic) fertilizers, multiple species culture, sufficiency of juvenile supplies, pure-strain breeding, use of granular feeds, etc.

Subject descriptors:
U.S.S.R.; economic concepts; methodolgy; development rationale; production data; outlook; revenue; costs; returns; history.

253
Szamborski, Jerzy.
1967.
Calculation of economic effectiveness of investments in fish farms (Rachunek efektywnosci ekonomicznej inwestycji w obiektach rybackich).
Gosp. Rybn. 19(7): 3-5. (Copy of translation available on loan from NMFS.)

The main factors that influence the evaluation of the economic effectiveness of an investment include: (1) duration of the investment cycle (period from construction initiation to first use of project), (2) the mass of envisaged production and the birth rate, (3) costs of production (operating costs plus the annual equivalent of capital costs, which are called costs of adaptation or transformation), and (4) length of time of exploitation of a planned investment. An example involving the computation of an index of effectiveness of a planned capital repair for a particular pond project is given, following an explanation and discussion of the variables and assumptions in the index. This index is essentially an annual cost benefit ratio and was obtained from the Polish Ministers' Planning Commission instructions on the ecomonic comparison and evaluation of the efficiency of investments. A previous application by the author is cited (1967, Gosp. Rybn. 19(2): 3-5).

Subject descriptors:
Investment model; benefit-cost analysis; economic concepts; methodology; Poland.

254
Szamborski, Jerzy.
1967.
Some elements of the economic efficiency of pond production (Niektore elementy ekonomicznej efecktywnosci produkcji stawowej).
Gosp. Rybn. 19 (2): 3-5. (Copy of translation available on loan from NMFS.)

Output per hectare of carp (ponds) and beef cattle (pasture) are compared on the basis of meat and protein weight, and live-animal value. This is done for the primary (natural) increase, then with specified amounts of fertilizer, and finally fertilizer and feed in specified amounts. Carp is clearly more productive. However, investment projects for the two kinds of production differ in several particulars and the author then explains and applies a general formula for comparing the efficiency of investments, as obtained from the Polish Ministers' Planning Commision instructions. This formula takes account of various costs in the numerator and the value of output in the denominator all on an annual basis. It is an annual cost/benefit ratio. [Annotator's note: certain computational assumptions differ from those sometimes used in U.S. water resource agency benefit-cost analyses respecting the interest rate or discounting rate effects of time, although a time-adjustment factor is used.] In terms of annual cost-benefit ratios, beef and carp are similar or closer in investment efficiency than they are on the basis of simple productivity, but if the flood prevention effects of carp ponds are counted, carp are again the winner over beef. Of course, possible exceptions for individual projects are recognized.

Subject descriptors:
Enterprise comparison; carp; beef cattle; productivity; benefit-cost analysis; economic concepts; economic feasibility; investment model; Poland.

255
Tal, S.
1973.
New prospects in fishculture in Israel.
Bamidgeh 25(3): 67-71.
New intensive fish culture methods are discussed. The 1972 yield from pond culture was 13,350 metric tons with an average productivity of 2.7 tons/ha of pond area. The Israeli market can handle up to 17,000 tons of all kinds of pondfish in 1973, but the actual yield will be only 15,000 tons. Since 1965, output has increased by 82%. The demand forecast for 1974/75 is 19,000 tons. To supply this demand, 4 tons per hectare from 5,000 hectares of ponds is necessary. Water limitation problems are also discussed. Unpotable, brackish waters are used for pisciculture to avoid fish farming at agriculture's expense. Investment, transition (from conventional to intensive fish culture), feed problems, and the possibility of marine farming are discussed. The new intensive culture method will introduce more efficient work methods.
Subject descriptors:
Israel; productivity; investment; outlook; forecasts.

256
Treasurer, J. W.
1974.
Fish farming--the future.
Fish Marketing, Processing, Packaging (17): 11 and 13.
While not discouraging fish farming, the author briefly challenges the views expressed by specific writers for possible cveroptimism.
Subject descriptors:
Constraints.

257
Trimble, Gordon M.
1972.
Legal and administrative aspects of an aquaculture policy for Hawaii: an assessment.
Hawaii, Dep. Plan. Econ. Dev., Cent. Sci. Policy Tech. Assessment, and West. Interstate Comm. Higher Educ., Resour. Dev. Internship Progr., 61 pp.
This report discusses an assessment of legal and administrative aspects of aquaculture in Hawaii initiated by the Governor's Advisory Committee on Science and Technology. Background information on laws, water rights, regulatory institutions, coastal zone statutes, water quality standard enforcement, State land use regulations, and the agencies responsible for each category are detailed. Fishing regulations, and agencies which provide technical and financial assistance for aquaculture activities and their programs are also outlined. A table of permits required for aquaculture activities is presented along

with a discussion of the impact of existing laws and institutions on aquaculture. Laws affecting aquaculture in other States are also presented.
Subject descriptors:
Institutions; legal barriers.

258
Webber, Harold H.
1972.
The design of an aquaculture enterprise.
Proc., Gulf Caribb. Fish. Inst., 24th Annu. Sess., Nov. 1971, pp. 117-125.
Among the factors judged to be important in determining the success of an aquaculture operation are those having to do with site selection, which the author emphasizes in this paper. Selection of sites is discussed with reference to ranch, pond, raceway, cage and closed (high-density) methods of culture. A comprehensive, extensive list of site selection criteria is provided.
Subject descriptors:
Site selection criteria.

259
Webber, Harold H.
1973.
Risks to the aquaculture enterprise.
Aquaculture 2(2): 157-172.
Successful operation of an aquaculture business requires enterpreneurship, knowledge of biological process uncertainties, management skill, and sufficient capital resources to achieve appropriate economies of scale. Risk aspects of commonly used problem or management areas for a hypothetical enterprise in the American Tropics are discussed independently, but their interdependence is recognized. Biological risks include diseases and parasites (a major problem), seed production, predation and competition, inventory control (serious since it impairs management), nutrition, and natural productivity. Physical risks include water quality and storm damage. Social and economic risks relate to political stability (in developing countries), land, labor, poaching, feed costs, and market changes. The discussion details the nature of various risks, and offers suggestions on possible degrees of risk interaction and risk losses in qualitative terms.
Subject descriptors:
Risks.

260
Wildman, Robert D.
1974.
Aquaculture in the National Sea Grant Program.
William N. Shaw, editor, Proceedings of the First U.S.-Japanese Meeting on Aquaculture at Tokyo, Japan, October 18-19, 1971. U.S. Dept. Commer., Natl. Mar. Fish. Serv., NOAA Tech. Rep. Circ. 388, pp. 41-56.
The National Sea Grant Program's aquaculture projects are described by type of organism being studied: crustaceans (shrimp, crabs, lobster, and crayfish), mollusks (oysters, clams, scallops, abalone, octopus, and limpets), finfish (salmonids, mullet, dolphin, and miscellaneous), and seaweeds (red and brown algae). As of June 30, 1971, the National Sea Grant Program was helping to support over 50 projects directly related to aquaculture with a total (joint or shared) cost of $5 million, and with over $3 million being from the Program. The research work, technological developments in rearing species, and specific universities and other institutions doing the work are discussed. Market potential of species, reproductive ability, environmental effects on species' productivity and feed data are among the specific terms discussed under each species. Also, programs in marine pathology directed at diseases of seafood organisms are discussed as well as new aquaculture sites. A listing of National Sea Grant Aquaculture Programs by organization is provided.
Subject descriptors:
Research; R&D role; public sector role; investment.

261
Williams, Simon.
1975.
Conflict of interest and its resolution as factors in the commercialization of aquaculture in the Americas.
Mar. Fish. Rev. 37(1): 48-51.
The author focuses on what he views to be a neglected area, "organizing the business of aquaculture so that its benefits ensure the maximum satisfaction of the people of a host country." Host country aspirations of national development, reactions to enclave and exploitive kinds of operations, actions to produce change, and problems are discussed, along with attitude and objective changes by private enterprise (e.g., acceptance of responsibility for general economic development, use of return on investment criteria that include interests of the host country, and willingness to share or eventually transfer ownership). Some examples of operating institutions in Mexico are given in the context of helping to resolve conflicts of interest between private (often foreign) investors and people of the host country.
Subject descriptors:
Economic development role; development planning; externalities; institutions.

262
Yee, William C.
1972.
Thermal aquaculture: engineering and economics.
Environ. Sci. Technol. 6(3): 232-237.

Thermal effluent from electric power generating plants is expected to be a matter of increasing concern as power output grows. The author provides information on his surveys of the experimental uses of this waste heat to hasten the growth of various aquatic species in several countries. Also, a design concept is discussed for an integrated shrimp culture operation at a power plant site. Operating and capital costs are estimated (including hatchery, growth to market size, and processing operations) in the context of using sensitivity analysis to determine economic feasibility at any site.

Subject descriptors:
Powerplant heat use; technology; method evaluation.

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☆GPO 796-407

NOAA Technical Report NMFS SSRF-704

The Macrofauna of the Surf Zone Off Folly Beach, South Carolina

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January 1977

U.S. DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary
National Oceanic and Atmospheric Administration
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The Macrofauna of the Surf Zone Off Folly Beach, South Carolina[1]

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ABSTRACT

A seining survey of the macrofauna of the surf zone at Folly Beach, Charleston County, S.C., was conducted from October 1969 to October 1971. Eighty-seven collections were made in the surf and associated tidal pool resulting in the capture of 512 specimens of swimming invertebrates representing at least 17 species and 5,095 specimens of bony fishes representing 41 species.

The data obtained are analyzed on seasonal and yearly bases for total weights and numbers of species and specimens. Species are ranked as to importance; and prediction equations for monthly average number of specimens per collection in the surf, based on environmental variables, are developed. Length-frequency data and other aspects of the biology of selected species are presented. Length-length and length-weight relationships are given for certain species. Recommendations for the improvement of the methodology for similar surveys are made.

INTRODUCTION

hough the taxonomy of the fishes and many of the invertebrates inhabiting the inshore waters and es-ries of South Carolina is reasonably well known, the istories of many of these species are incompletely —data on the larvae and juveniles and on the hal variations and fluctuations of populations being ecially limited. This study was initiated with the in- f filling part of this gap in our knowledge of the surf

n several studies since 1940, the ichthyofauna of the f zone has been surveyed along the Gulf and Atlantic of the United States [e.g., Gunter (1945, 1958) and rland (1963) in Texas; Springer and Woodburn 60) in the Tampa Bay area; Miller and Jorgenson 69) and Dahlberg (1972) in Georgia; Cupka (1972) in Carolina; Tagatz and Dudley (1961) in North na; and Schaefer (1967) in New York], but to our owledge no surveys have been conducted on a regular round basis north of North Carolina in the surf of unprotected beaches.

the many shore habitats, the surf zone of exposed ches has been least studied. Part of the paucity of on the surf zone is certainly due to the difficulties nt in collecting in it. It is unfortunate that our owledge of this environment is so meager because this her extensive and physically well-defined habitat is ly economically important as a recreational area for sport fishermen, but also is significant as nursery grounds for certain commercial and sport species such as the pompanos, *Trachinotus* spp., mullets, *Mugil* spp., and Gulf kingfish, *Menticirrhus littoralis*. Other species inhabiting the surf undoubtedly prey upon or form a significant part of the diet of a number of economically important species. In order to adequately understand the ecology of the surf zone, basic data on the composition and seasonal variations and fluctuations of populations of both resident and transient species are necessary. With the preceding in mind, a 2-yr biweekly seining survey was initiated at Folly Beach in October 1969. A short abstract of the first year of this study was presented by Anderson et al. (1971).

DESCRIPTION OF THE STATION

Folly Beach (on Folly Island, a barrier island) is about 14 km south of the Charleston peninsula in Charleston County, S.C. The littoral zone at this beach is a high-energy environment, unprotected from the force of the open Atlantic Ocean by any physiographic feature. Collections were made in the surf (i.e., the breakers and slightly seaward) and tidal pool (when present) between the last two groins at the southwestern end of the beach (lat. 32°38.7′N, long. 79°57.6′W). The beach slopes gently in this area (about 1-1½%) and is predominantly sandy (fine sand), although considerable shell and larger shell fragments were present on about one-half of the collecting days. Tidal ranges are 5.2 feet (1.58 m) mean and 6.1 feet (1.86 m) spring. The height of the sea varied from about 0.2 to 2.1 m ($\bar{x}$ = 0.6 m).

A tidal pool[6] was present on approximately 70% of the collecting days. Its dimensions varied considerably from

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[6] A "tidal pool" is "A pool of water remaining on a beach or reef after recession of the tide" (Howell 1960).

one collection to the next. On several occasions it was limited to a small pool at the seaward end of one (or of each) groin and on others was a very long trough in excess of 200 m in length. Because the groins (of timber pilings) were well covered with encrusting invertebrates and because the currents tended to scour out the areas at the seaward ends of the groins, these man-made structures acted as unnatural foci for the concentration of motile animals. Despite this the presence of the groins affected only the catch in the tidal pool, because at the times we made the surf collections the tide had receded beyond the groins.

The minimum and maximum water temperatures observed were: surf, 6.4° and 28.6°C; tidal pool, 3.7° and 26.8°C. The salinities in the surf ranged from 23.2 to 35.0‰; those in the tidal pool, from 25.8 to 33.4‰. (For data on temperature and salinity, see Tables 1 and 2.) The lowest salinities were recorded after heavy local rains. Because the collections were made near the time of predicted low water, the maximum diluting effect of the groundwater was manifest.

MATERIALS AND METHODS

Collecting and Handling Specimens and Data

Collections were made by seine at approximately biweekly intervals (from 11 October 1969 to 10 October 1971) in the surf and tidal pool (when present) near the time of predicted low water. All except three of the collections were made in the morning (0500-1130 EST). The time required to make a collection varied from 5 to 40 min ($\bar{x}$ = 15.4) in the surf and from 1 to 25 min ($\bar{x}$ = 10.3) in the tidal pool.

The surf was seined with a 19.8- by 1.8-m, 9-mm stretch-mesh nylon bag seine with bag opening of 1.8 m in diameter and length of 1.8 m. Initially, the tidal-pool collections were made with the 19.8-m seine—later (because of ease of handling) with a 7.1- by 1.6-m, 9-mm stretch-mesh nylon bag seine with bag opening of 1.8 m in diameter and length of 1.8 m. Except when beaching and when collecting in the tidal pool was restricted to small pools at the groins, the seines were pulled parallel to the beach.

In the surf, the seine was pulled approximately 185 m, the distance between the groins. During almost all of the first year, two hauls, each about one-half the distance between the groins, were made—the first haul starting opposite one groin, the second terminating opposite the other. Later each surf collection was made with a single tow. Generally, the seine was towed with the longshore current which usually ran from northeast to southwest. The distance seined and the number of hauls in the tidal pool varied with the length and configuration of the pool, but never exceeded 185 m. The use of seines of different lengths did not affect the catch in the tidal pool because even the smaller seine was long enough to reach across the width of the pool. There were no duplicate or reciprocal tows in either the surf or tidal pool, i.e., a given area was seined only once per collecting trip.

Assuming that the opening of the seine was 12 m (±2
the area covered in a seine haul between the groins in
surf was about 2,220 m². Surf and tidal-pool ca
made on the same day were considered as dif
collections and were handled separately. Air and w
temperatures, salinity, and turbidity were measured
observations were made on the condition of the
height of the breakers, wind velocity and direction,
cover, character of the bottom, and depth of water se

All material was measured and weighed after pres
tion. Standard length (SL), fork length (FL)—
applicable, total length (TL), and weight (W) of
fish were taken. Specimens were thoroughly blotte
ternally and excess moisture was squeezed out of t
chambers of fishes before weighing. Similar techn
were used for invertebrates except that carapace le
(CL) and width (CW) were measured on crabs.

Data were coded for input on 80-column Hollerith
punch cards. Four types of cards were used for
collection: 1) location data card, 2) physical data ca
species data card (number of specimens, total we
and length and weight ranges), and 4) specimen
card (scientific name, sex if determined, lengths, w
and miscellaneous data as appropriate). Data
analyzed on an IBM System 360/40 DOS compute
software used for the analyses of the data wa
Dynamic Computer Systems/Multi-purpose Inform
Processor and the UCLA BMD, Biomedical Com
Programs.

In this study we define the seasons as follows: Oc
November, December—Fall; January, Febr
March—Winter; April, May, June—Spring; and
August, September—Summer.

Selectivity of Collecting Method

The method of collecting used in this study was
selective. The material that could be collected by s
was determined by the characteristics of the net (l
configuration, and mesh size), certain environn
factors, and the speed at which the net could be p
which is largely a reflection of environmental cond
In the surf the environmental factors with the gr
effects were velocity of longshore current, conditio
height of sea, nature of bottom, temperature, an
bidity; in the tidal pool those of greatest importanc
conditions prevailing at the previous flood tide a
configuration of the pool itself which was a product
conditions existing at the time of formation.

In the surf large individuals were not as
collected as smaller ones; however, at times of low
temperatures the motility of larger animals was re
greatly, thereby decreasing their chances of es
capture. Individuals less than a certain critical
function of mesh size) were not retained in the net
they became entrapped with other animals and de
the bag of the seine.

The seine was usually pulled with the lon
current because most frequently it was imposs
make headway against it. Even though our hauls w

most part with the current, the time required to cover distance between the groins varied considerably se of differences in current velocity. Our catch, was affected both qualitatively and quantitatively unknown degrees by variations in the current.

n the tidal pool all individuals greater than a certain al size would appear to be captured with ease. ver, experience showed that this was not the case. e to the configuration of the tidal pool, particularly it was in part or entirely associated with one (or of the groins, animals were seen that were not ted.

RESULTS AND DISCUSSION

llections

total of 87 collections were made, 51 in the surf e 1) and 36 in the tidal pool (Table 2). Each collec- n in the surf yielded at least one species of fish (1-9) ll but 14 at least one swimming invertebrate species Twenty-eight of the 36 collections in the tidal pool ced at least one species of fish (1-7), but swimming ertebrates (one species) were obtained in only eight tions. The total number of species of fishes and ming invertebrates varied from 1 to 13 per collec- in the surf and 0 to 7 in the tidal pool.

The number of fishes per collection in the surf varied 2 to 310; the number of swimming invertebrates 0 to 79. In the tidal pool the number of fishes per lection ranged from 0 to 759; the number of swimming ertebrates from 0 to 12. The total number of specimens hes and swimming invertebrates ranged from 2 to er station in the surf and 0 to 759 in the tidal pool.

The weight of fishes per collection in the surf varied 7 to 2,045 g, that of swimming invertebrates from 0 5 g. The weight of fishes per collection in the tidal varied from 0 to 817 g, that of swimming in- tebrates from 0 to 7 g. The total weight of fishes and ming invertebrates varied from 7 to 2,047 g per sta- n the surf, and from 0 to 817 g in the tidal pool.

Some 512 specimens of swimming invertebrates resenting 4 phyla, 4 classes, 6 orders, 11 families, 15 genera, and at least 17 species; and 5,095 mens of bony fishes representing 7 orders, 19 ilies, 32 genera, and 41 species were collected and examined during this study. About 350 specimens senting at least 32 additional species of in- brates were also collected. This group of species in- ded nonswimming motile forms characteristic of er offshore waters, unattached bottom-dwellers of rf zone (such as pelecypods and echinoderms), and hed offshore sessile organisms. Seventeen of these ecies (represented by 102 specimens) were collected n 16 July 1971 shortly after a tropical storm passed the coast of South Carolina. Because these 32 ad- ional species of invertebrates are not ordinarily found the surf zone or are bottom-dwellers not adequately led by our method of collection, they are not con- d further.

Sixteen of the 17 species of swimming invertebrates were found in the surf, but only five were found in the tidal pool. Nearly all of the specimens (491 of 512) and nearly all of the mass of swimming invertebrates (4,291 of 4,300 g) were found in the surf.

All 41 species of fishes collected were found in the surf, but only 16 appeared in the tidal pool. Approximately 54% of the specimens (2,747) were seined in the surf and about 46% (2,348) in the tidal pool. Approximately 74% (12,866 g) of the ichthyomass was caught in the surf and about 26% (4,452 g) in the tidal pool. The mean weight of fishes from the surf was more than twice the mean weight of those from the tidal pool (4.68 to 1.90 g). Larger fishes tend to avoid being trapped in shallow tidal pools as the tide ebbs, whereas smaller individuals may find refuge in these relatively predator-free pools. It is conceivable that these transient pools provide havens that are important to the survival of the fry of species such as *Trachinotus carolinus* and *Mugil curema* and to individuals of most size ranges of *Fundulus majalis* and *Menidia menidia*. Individuals of the latter two species may seek these quiet waters for feeding. Although one of the effects of fishes concentrating in a tidal pool is to make them more vulnerable to some piscivorous birds, the advantages of temporary residence in an isolated pool (protection from predatory fishes and certain birds and the availability of food) may far outweigh this disadvantage. Of the most important species, the fishes *Anchoa mitchilli* and *Menticirrhus littoralis* and the decapod crustacean *Arenaeus cribrarius* were collected almost exclusively in the surf, while the fish *Fundulus majalis* was caught almost entirely in the tidal pool. Table 3 presents summaries of data on collections, size ranges, total weights, temperature, and salinity for fishes and *Arenaeus cribrarius*, and Table 4 presents the monthly size range and number collected per month for fishes and *A. cribrarius*. In both tables *A. cribrarius* is included because it was the only invertebrate species collected in sufficient numbers for analysis. Data on the other swimming invertebrates collected are presented in Table 5.

The numbers of specimens collected were quite small compared with those of some surveys. Our small catches resulted from the difficulties encountered in collecting in the surf and the limitations imposed by our sampling procedure (the absence of replicate tows and collecting sites and the use of a small beach seine). The similarities in the two years in the compositions of the collections and the seasonal trends indicate that our methodology was adequate for giving an estimate of some of the environmental and population parameters of the area.

Comparisons of Yearly and Seasonal Abundance of Fishes

Comparisons of numbers of species and specimens and total weights of fishes are presented in Table 6. These are discussed in this section. In the section on the Analysis of Abundance of Fishes, the statistics of the data given in Table 6 are examined.

Table 1.—List of collections made in the surf during survey of Folly Beach, S.C. (Oct. 1969-Oct. 1971). F = Fish; I = Swimming invertebrates. Plus indicates imcomplete data; dash indicates no data taken: < indicates weights of 0.5 g or less.

Date	Temperature (°C)	Salinity (‰)	No. of species F	No. of species I	No. of specimens F	No. of specimens I	Total weight (g) F	Total weight (g) I
1969								
11 Oct.	24.5	33.0	5	3	25	20	56	354
18 Oct.	21.0	32.8	6	1	77	4	180	135
1 Nov.	17.5	31.2	2	1	3	2	11	39
16 Nov.	11.4	32.9	5	0	54	0	312	0
2 Dec.	11.0	31.4	2	0	3	0	75	0
17 Dec.	9.3	29.0	6	0	195	0	461	0
1970								
2 Jan.	8.8	32.8	4	0	97	0	307	0
15 Jan.	6.7	27.7	7	2	39	6	1,252	39
1 Feb.	7.4	32.2	2	0	47	0	121	0
14 Feb.	8.9	32.1	2	1	58	2	162	<
1 Mar.	9.9	33.2	1	0	15	0	50	0
15 Mar.	11.1	32.6	1	0	9	0	32	0
31 Mar.	15.3	26.4	2	1	130	1	520	5
12 Apr.	16.0	23.2	2	0	14	0	63	0
25 Apr.	21.5	31.8	7	2	37	3	162	14
11 May	22.5	32.6	3	2	7	6	16	103
26 May	23.2	32.6	4	2	12	4	24	—
9 June	23.8	28.0	7	4	21	19	1,294	276
23 June	27.2	31.2	6	1	51	44	188	166+
11 July	26.7	31.2	9	4	45	8	96	16+
25 July	28.3	35.0	7	2	16	6	289	207+
8 Aug.	26.0	32.3	3	1	25	79	166	56+
24 Aug.	28.6	33.9	6	2	21	13	102	7
9 Sept.	25.6	30.2	5	2	15	8	58	108
23 Sept.	26.9	29.6	5	1	113	2	2,045	2+
10 Oct.	23.0	31.2	3	1	7	3	8	31+
24 Oct.	20.4	31.2	5	1	46	8	486	16
7 Nov.	15.3	32.3	9	0	71	0	193	0
22 Nov.	14.6	29.1	2	1	4	1	19	<
6 Dec.	13.0	29.6	4	0	74	0	229	0
22 Dec.	13.3	34.5	2	0	2	0	7	0
1971								
4 Jan.	10.2	28.0	1	0	8	0	26	0
21 Jan.	6.4	31.2	6	1	310	1	571	<
6 Feb.	9.0	27.0	5	0	244	0	626	0
20 Feb.	10.8	26.4	3	0	132	0	472	0
8 Mar.	10.9	30.2	5	1	39	1	63	—
21 Mar.	11.0	31.8	4	2	78	6	156	13
6 Apr.	14.2	30.2	5	2	13	10	186	22
17 Apr.	15.3	31.2	5	2	34	4	184	80
2 May	19.0	28.0	5	4	14	10	212	95
16 May	21.1	28.0	3	2	3	11	29	152
30 May	21.6	29.1	6	1	15	1	21	19
14 June	24.9	33.4	7	1	81	9	293	165
28 June	27.2	32.8	4	3	28	8	85	204
16 July	27.4	33.4	7	6	80	47	128	446
30 July	27.8	31.5	6	2	66	13	126	19
13 Aug.	26.8	29.6	9	1	38	1	206	1
28 Aug.	27.0	32.3	4	1	41	34	112	341
12 Sept.	26.2	32.8	8	5	161	61	319+	655
26 Sept.	24.2	29.2	3	1	12	5	14	67
10 Oct.	23.5	27.5	5	2	17	30	53+	438

Surf.—More species and more specimens of fishes were caught in the surf during the second year than in the first year, but the weight of fishes caught in the second year was only 60% of those caught in the first year (see Table 6). A considerable portion of this difference was due to the capture during the first year of 20 *Mugil cephalus* with a total weight in excess of 1.5 kg and a single specimen of *Pogonias cromis* which weighed than 1.2 kg.

Comparisons of seasonal catches between the years show close similarities in numbers of species i responding seasons except summer. The summer c second year produced almost half again as many sp as that of the first year. Winter, spring, and summ

Table 2.—List of collections made in the tidal pool (when present) during survey of Folly Beach, S.C. (Oct. 1969-Oct. 1971). F = Fish; I = Swimming invertebrates. Plus indicates incomplete data; dash indicates no data taken; < indicates weights of 0.5 g or less.

Date	Temperature (°C)	Salinity (‰)	No. of species		No. of specimens		Total weight (g)	
			F	I	F	I	F	I
1969								
11 Oct.	26.8	—	6	1	130	2	365+	<
18 Oct.	17.0	—	5	0	14	0	38	0
16 Nov.	11.2	32.0	1	0	14	0	41	0
2 Dec.	10.8	32.0	3	1	58	12	809	—
17 Dec.	7.9	28.1	1	0	1	0	5	0
1970								
2 Jan.	8.0	32.5	1	0	5	0	22	0
15 Jan.	6.2	26.2	1	0	4	0	16	0
1 Feb.	7.3	30.7	0	0	0	0	0	0
15 Mar.	8.4	32.4	1	0	5	0	21	0
11 May	21.6	31.6	3	0	76	0	268	0
26 May	21.1	31.8	6	0	251	0	817	0
9 June	22.8	28.0	7	0	759	0	295	0
23 June	24.8	28.0	3	1	366	1	236	7
11 July	23.4	28.5	4	1	73	1	215	<
25 July	26.3	32.3	2	1	5	1	9	1
8 Aug.	24.6	30.7	4	1	159	1	239	<
9 Sept.	24.2	29.6	2	0	3	0	5	0
23 Sept.	25.6	28.5	1	0	5	0	1	0
10 Oct.	24.3	31.2	3	0	51	0	1	0
7 Nov.	14.6	31.2	5	0	52	0	149	0
22 Nov.	14.2	31.2	2	0	132	0	461	0
6 Dec.	10.7	29.6	0	0	0	0	0	0
22 Dec.	14.0	32.3	1	0	50	0	218	0
1971								
4 Jan.	11.2	25.8	3	0	17	0	67	0
21 Jan.	3.7	28.5	0	0	0	0	0	0
6 Feb.	11.0	27.0	1	0	1	0	<	0
17 Apr.	14.9	30.2	3	0	49	0	14	0
2 May	18.0	25.8	1	0	4	0	14	0
16 May	19.8	28.0	1	0	4	0	13	0
30 May	18.5	29.1	0	0	0	0	0	0
14 June	24.0	33.4	0	0	0	0	0	0
28 June	25.1	31.2	0	0	0	0	0	0
16 July	24.5	31.2	0	0	0	0	0	0
13 Aug.	24.2	29.6	0	0	0	0	0	0
12 Sept.	25.5	32.3	4	1	46	1	73	—
10 Oct.	23.0	28.0	4	1	14	2	28	1

econd year each yielded more specimens than in the st year, with winter and summer each being a great al more productive. In each season of the first year a er total mass of fishes was collected than in the season in the second year.

A comparison of data for seasons for both years comned shows that more species were caught in summer in any other season and that diversity was least in r. In contrast, most specimens and greatest mass re obtained in winter, whereas the least number of in- viduals and smallest mass appeared in the spring and catches, respectively. For the most part, the in- dual years followed the same pattern. The high diver- y in the warmer months was expected, but the large ber of individuals and great mass caught during the r was not anticipated. The large winter catch, ative to other seasons, may be due to at least two fac- rs—motility and preferences for particular erature regimes. Most of the larger, faster fishes were caught in cold water could have easily avoided the seine when the water was warm. *Menidia menidia*, the most abundant species, was caught over a wide range of temperature (6.4°-28.3°C), but was most plentiful at the lower end of that range, whereas *Trachinotus carolinus* and *Mugil curema* (two of the most common species of fishes) were not collected at temperatures less than 14.6° and 14.9°C, respectively.

Tidal pool.—More species, more individuals, and greater mass of fishes were collected in the tidal pool during the first year than in the second year (see Table 6). These differences appear to be largely due to chance. A tidal pool was present on 18 of the collecting days each year, but only 1 of the 18 yielded no fishes or invertebrates in the first year; in contrast 7 produced no specimens in the second year. The absence of fishes from a particular collection in the tidal pool was apparently not entirely related to temperature because three collections which produced none were made in December, January, and February (water temperature: 3.7-10.7°C)

Table 3.—Summary data for *Arenaeus cribrarius* and fishes collected during survey of Folly Beach, S.C. (Oct. 1969-Oct. 1971).

Species	Number collected and times (in parentheses) surf	tidal pool	total	Size range (mm SL)	Total weight (g)	Temperature range (°C)	Salinit range (°/oo)
Portunidae (Decapoda, Crustacea)							
Arenaeus cribrarius	417(32)	5(3)	422(35)	[1]7-141	3,218+	11.0-28.6	27.5-35.
Elopidae							
Elops saurus	1(1)	0	1(1)	220	111	26.2	32.8
Clupeidae							
Alosa aestivalis	22(5)	0	22(5)	42-62	29	6.4-10.9	27.7-32.
Brevoortia smithi	1(1)	0	1(1)	89	13	6.7	27.
Brevoortia tyrannus	18(3)	0	18(3)	49-99	87	6.4-9.3	27.0-31.2
Dorosoma petenense	1(1)	0	1(1)	73	7	28.6	33.9
Opisthonema oglinum	15(1)	0	15(1)	63-80	78	26.8	29.
Engraulidae							
Anchoa hepsetus	22(7)	3(1)	25(8)	36-78	70	15.3-28.6	29.6-33.
Anchoa mitchilli	362(29)	10(1)	372(30)	20-60	365	6.4-28.6	27.5-35.0
Ariidae							
Arius felis	1(1)	1(1)	2(2)	229-237	347	19.0-23.4	28.0-28.
Cyprinodontidae							
Cyprinodon variegatus	2(1)	2(2)	4(3)	26-32	4	9.3-11.2	25.8-32.
Fundulus heteroclitus	1(1)	3(1)	4(2)	25-38	3	11.4-14.6	31.2-32.
Fundulus majalis	3(3)	341(15)	344(18)	26-84	744	6.2-26.8	25.8-33.
Fundulus sp.	0	2(2)	2(2)	57	8	6.2-22.8	26.2-28.
Atherinidae							
Membras martinica	14(8)	0	14(8)	44-83	42	9.0-26.8	23.2-33.
Menidia beryllina	22(10)	4(4)	26(14)	46-75	53	6.4-22.8	26.4-32.
Menidia menidia	1,485(36)	630(18)	2,115(54)	21-89	6,226	6.4-28.3	23.2-35.
Pomatomidae							
Pomatomus saltatrix	2(2)	0	2(2)	93-122	38	23.8-26.7	28.0-31.
Carangidae							
Caranx hippos	2(2)	0	2(2)	28-34	2	26.8-28.3	29.6-35.
Chloroscombrus chrysurus	6(3)	0	6(3)	20-54	6	26.2-27.8	29.6-32.
Trachinotus carolinus	266(29)	710(13)	976(42)	12-93	1,519	14.6-28.6	27.5-35.
Trachinotus falcatus	7(5)	41(7)	48(12)	12-59	47	15.3-26.8	28.0-33.
Trachinotus goodei	4(3)	0	4(3)	18-91	23	21.0-26.0	31.2-32.
Gerreidae							
Eucinostomus sp.	1(1)	2(1)	3(2)	14-28	1	24.3-24.5	31.2-33.
Sparidae							
Archosargus probatocephalus	1(1)	0	1(1)	118	70	6.7	27.
Sciaenidae							
Bairdiella chrysura	1(1)	0	1(1)	93	17	15.3	32.
Larimus fasciatus	4(1)	0	4(1)	15-34	4	26.2	32.
Leiostomus xanthurus	2(2)	0	2(2)	38-102	26	21.1-21.5	28.0-31.
Menticirrhus littoralis	291(34)	3(2)	294(36)	19-149	843	6.7-28.6	26.4-35.
Menticirrhus saxatilis	3(2)	1(1)	4(3)	33-50	5	22.8-27.2	28.0-33.
Menticirrhus sp.	3(2)	1(1)	4(3)	27-38	2	14.6-26.2	31.2-33.
Pogonias cromis	1(1)	0	1(1)	328	1,228	23.8	28.
Stellifer lanceolatus	1(1)	0	1(1)	51	3	14.2	30.
Mugilidae							
Mugil cephalus	26(8)	47(3)	73(11)	17-328	2,426	6.4-28.3	27.0-35
Mugil curema	121(9)	545(7)	666(16)	19-130	2,709	14.9-28.6	28.0-35
Scombridae							
Scomberomorus maculatus	1(1)	0	1(1)	106	11	27.4	33
Triglidae							
Prionotus sp.	2(2)	0	2(2)	24-26	1	26.2-27.4	32.8-33
Bothidae							
Paralichthys squamilentus	17(9)	2(1)	19(10)	34-115	82	15.3-27.4	27.5-33
Scophthalmus aquosus	1(1)	0	1(1)	81	14	15.3	32
Soleidae							
Trinectes maculatus	1(1)	0	1(1)	100	45	21.5	31
Balistidae							
Monacanthus hispidus	6(4)	0	6(4)	16-22	2	15.3-27.0	29.1-32
Tetraodontidae							
Sphoeroides maculatus	5(2)	0	5(2)	14-18	2	27.2-27.8	31.5-32
Sphoeroides spengleri	1(1)	0	1(1)	16	<1	23.5	27
Diodontidae							
Chilomycterus?	2(1)	0	2(1)	12-16	1	27.4	33

[1] Carapace width in millimeters.

Species	January	February	March	April	May	June	July	August	September	October	November	December
Portunidae (Decapoda, Crustacea)												
Arenaeus cribrarius[1]	0	0	(1)28	(13)28-98	(25)17-70	(76)21-102	(57)16-140	(126)14-141	(55)7-134	(66)17-103	(3)23-79	0
Elopidae												
Elops saurus	0	0	0	0	0	0	0	0	(1)220	0	0	0
Clupeidae												
Alosa aestivalis	(15)42-55	0	(6)44-62	0	0	0	0	0	0	0	0	(1)49
Brevoortia smithi	(1)89	0	0	0	0	0	0	0	0	0	0	0
Brevoortia tyrannus	(1)83	(1)99	0	0	0	0	0	0	0	0	0	(16)49-69
Dorosoma petenense	0	0	0	0	0	0	0	(1)73	0	0	0	0
Opisthonema oglinum	0	0	0	0	0	0	0	(15)63-80	0	0	0	0
Engraulidae												
Anchoa hepsetus	0	0	0	0	0	0	(8)36-58	(2)61-72	(9)56-69	(3)68-76	(3)72-78	0
Anchoa mitchilli	(5)42-46	0	(33)34-57	(13)39-51	(21)40-59	(45)42-57	(55)32-54	(4)39-46	(126)20-54	(54)32-60	(15)38-52	(1)29
Ariidae												
Arius felis	0	0	0	0	(1)237	0	(1)229	0	0	0	0	0
Cyprinodontidae												
Cyprinodon variegatus	(1)26	0	0	0	0	0	0	0	0	0	0	(3)30-32
Fundulus heteroclitus	0	0	0	0	0	0	0	0	0	0	(4)25-38	0
Fundulus majalis	(5)46-67	(1)38	0	0	(9)63-84	(24)26-74	(58)26-48	(143)31-61	(44)34-62	(2)47-63	(6)49-65	(52)45-81
Fundulus sp.	(1)57	0	0	0	0	(1)57	0	0	0	0	0	0
Atherinidae												
Membras martinica	0	(1)58	(1)44	(2)77-83	0	(2)78-80	(1)69	(2)52-54	(2)56-61	0	0	(3)48-71
Menidia beryllina	(9)52-70	(4)60-75	(3)53-62	(1)73	(2)46-63	(1)65	0	0	0	0	(2)52-61	(4)53-62
Menidia menidia	(423)49-85	(470)51-87	(226)55-89	(58)58-82	(277)57-86	(20)21-84	(4)67-87	(1)31	(1)57	(92)51-73	(248)54-82	(295)47-83
Pomatomidae												
Pomatomus saltatrix	0	0	0	0	0	(1)93	(1)122	0	0	0	0	0
Carangidae												
Caranx hippos	0	0	0	0	0	0	(1)34	(1)28	0	0	0	0
Chloroscombrus chrysurus	0	0	0	0	0	0	(1)20	(4)21-54	(1)34	0	0	0
Trachinotus carolinus	0	0	0	(1)13	(26)14-47	(695)12-75	(59)22-90	(45)19-93	(13)14-61	(121)13-77	(16)34-69	0
Trachinotus falcatus	0	0	0	0	0	(3)14-25	0	(1)52	(5)15-35	(38)12-59	(1)58	0
Trachinotus goodei	0	0	0	0	0	0	0	(1)91	0	(3)18-30	0	0
Gerreidae												
Eucinostomus sp.	0	0	0	0	0	0	0	0	0	(3)14-28	0	0
Sparidae												
Archosargus probatocephalus	(1)118	0	0	0	0	0	0	0	0	0	0	0
Sciaenidae												
Bairdiella chrysura	0	0	0	0	0	0	0	0	0	0	(1)93	0
Larimus fasciatus	0	0	0	0	0	0	0	0	(4)15-34	0	0	0
Leiostomus xanthurus	0	0	0	(1)38	(1)102	0	0	0	0	0	0	0
Menticirrhus littoralis	(1)60	(4)83-145	(5)60-75	(18)46-112	(1)82	(12)26-103	(57)19-149	(54)25-104	(71)22-94	(37)22-76	(29)28-103	(5)62-102
Menticirrhus saxatilis	0	0	0	0	0	(4)33-50	0	0	0	0	0	0
Menticirrhus sp.	0	0	0	0	0	0	0	0	(2)33-38	(1)27	(1)36	0
Pogonias cromis	0	0	0	0	0	(1)328	0	0	0	0	0	0
Stellifer lanceolatus	0	0	0	(1)51	0	0	0	0	0	0	0	0
Mugilidae												
Mugil cephalus	(17)102-229	(1)24	(2)25-26	(47)17-211	0	0	(2)175-198	0	0	0	(1)195	(3)130-328
Mugil curema	0	0	0	(2)20-21	(36)20-25	(492)19-30	(26)21-69	(9)85-100	(75)86-130	(26)20-112	0	0
Scombridae												
Scomberomorus maculatus	0	0	0	0	0	0	(1)106	0	0	0	0	0

Table 4.—Continued.

Species	January	February	March	April	May	June	July	August	September	October	November	December
Bothidae												
Paralichthys squamilentus	0	0	0	(2)34-38	(11)42-58	(4)46-56	(1)82	0	0	(1)115	0	0
Scophthalmus aquosus	0	0	0	0	0	0	0	0	0	0	(1)81	0
Soleidae												
Trinectes maculatus	0	0	0	(1)100	0	0	0	0	0	0	0	0
Balistidae												
Monacanthus hispidus	0	0	0	0	(1)16	0	(2)16	(1)22	0	0	(2)18-19	0
Tetraodontidae												
Sphoeroides maculatus	0	0	0	0	0	(1)18	(4)14-18	0	0	0	0	0
Sphoeroides spengleri	0	0	0	0	0	0	0	0	0	(1)16	0	0
Diodontidae												
Chilomycterus ?	0	0	0	0	0	0	(2)12-16	0	0	0	0	0

[1] Measurements = carapace width in millimeters.

and five were made in May, June, July, and August (water temperature: 18.5°-25.1°C). Several of the pools from which no specimens were collected were for most part extremely shallow (0.1 m or less in depth were oriented at the seaward end of a groin in a manner which made it impossible to make a good seine haul. Considerable portions of the discrepancies in num and weights between the two years were the result of capture of large numbers of small *Fundulus majalis*, *Trachinotus carolinus*, and *Mugil curema* in the ti pool during the first year.

Comparisons of seasonal catches between the years show close similarities in numbers of species in all seasons except spring. The spring of the first produced 3 times as many species as the spring of the ond year. Fall and winter of the second year each yielded more specimens than their counterparts of the first year but spring and summer of the second year each had few specimens as compared to the corresponding sea in the first year. In each season of the first year except winter a greater mass of fishes was collected than in the same season in the second year.

A comparison of data for seasons for both years c bined demonstrates that species diversity was greatest i fall and spring and least in winter, that numbe specimens collected was greatest in spring and leas winter, and that greatest mass was obtained in fall least in winter. Because the first year dominated th combined catch for both years, it followed essentially same pattern, but the second year differed considera

Surf and tidal pool combined.—When the surf tidal pool were considered as a unit, the second produced more species, but fewer specimens and weight than the first year (see Table 6).

Comparisons of seasonal catches between the years show close similarities in numbers of species in responding seasons except summer. The summer of t second year produced almost a third more species th that of the first year. With regard to number specimens, fall and summer of the first year were similar to the same seasons in the second year, but t winter of the second year produced about twice as m individuals as that of the first year and the spring o first year 6.5 times as many as that of the second year. each season of the first year a greater mass of fishes w collected than in the same season of the second ye

A comparison of data for seasons for both years c bined shows that more species were caught in summ than in any other season, and that diversity was less fall and spring and much less in winter. The grea number of specimens were collected in spring and least in summer. The greatest mass appeared in win but spring produced almost as much and summer fall were not far behind. The individual years follo different patterns of seasonal distribution.

Comparison of surf with tidal pool.—During years more species and a greater mass of fishes le 5.—Summary data for swimming invertebrates (except *Arenaeus cribrarius*) collected during survey of Folly Beach, S.C. (Oct. 1969-Oct. 1971).

Species	Number collected and times (in parentheses)			Season(s) collected				Temperature range	Salinity range
	surf	tidal pool	total	fall	winter	spring	summer	(°C)	(°/₀₀)
nidaria									
yphozoa									
One (?) unidentified species (damaged)	2(2)	0	2(2)		X	X		10.9-19.0	28.0-30.2
ollusca									
ephalopoda									
Lolliguncula brevis	1(1)	0	1(1)	X				23.5	27.5
elida									
Polychaeta									
Nereis succinea	3(2)	1(1)	4(3)				X	25.5-27.4	32.3-33.4
ropoda									
ustacea									
Isopoda									
Aegathoa oculata	1(1)	0	1(1)				X	28.6	33.9
Decapoda									
Acetes americanus carolinae	3(1)	0	3(1)				X	26.2	32.8
Callinectes ornatus	0	1(1)	1(1)				X	26.3	32.3
Callinectes sapidus	9(8)	12(1)	21(9)	X		X	X	10.8-28.3	28.0-35.0
Emerita talpoida	3(3)	2(2)	5(5)			X	X	19.0-26.7	28.0-31.2
Emerita sp., fragment	1(1)	0	1(1)			X		23.2	32.6
Ogyrides alphaerostris	1(1)	0	1(1)			X		27.2	32.8
Ovalipes ocellatus	14(8)	0	14(8)		X	X		11.0-23.8	26.4-31.8
Palaemonetes pugio	5(3)	0	5(3)		X		X	6.4-26.7	31.2-32.1
Penaeus setiferus	21(4)	0	21(4)		X		X	6.7-27.4	27.7-33.4
Portunus anceps	5(1)	0	5(1)				X	27.4	33.4
Portunus gibbesii	1(1)	0	1(1)				X	27.4	33.4
Trachypenaeus constrictus	1(1)	0	1(1)	X				24.5	33.0
Stomatopoda									
Squilla empusa	2(1)	0	2(1)		X			6.7	27.7
One unidentified species (larva)	1(1)	0	1(1)				X	26.7	31.2

llected in the surf than in the tidal pool (see Table 6). he first year more specimens were captured in the dal pool than in the surf, but in the second year the opposite was true. Captures of large numbers of small fishes he tidal pool during the spring of the first year accounts for most of this variation between years.

Considering the first and second years combined, more species, greater numbers, and a greater mass were collected in the surf than in the tidal pool. In the surf as compared with the tidal pool, species diversity was

le 6.—Numbers of species and specimens and total weights of fishes (in grams) collected in the surf, tidal pool, and surf and tidal pool combined at Folly Beach, S.C. (Oct. 1969-Oct. 1971).

		Surf			Tidal pool			Surf and tidal pool combined		
		Number species collected[1]	Number specimens collected	Total weight collected	Number species collected[1]	Number specimens collected	Total weight collected	Number species collected[1]	Number specimens collected	Total weight collected
	fall	14	357	1,095	9	217	1,258	16	574	2,353
ear	winter	9	395	2,445	2	14	58	9	409	2,503
	spring	14	142	1,748	9	1,452	1,617	15	1,594	3,365
	summer	13	235	2,755	6	245	469	16	480	3,224
Total		28	1,129	8,043	14	1,928	3,402	29	3,057	11,445
econd	fall	12	204	942	8	285	842	17	489	1,784
year	winter	8	811	1,914	4	18	67	11	829	1,981
	spring	14	188	1,010	3	57	40	14	245	1,050
	summer	19	415	957	5	60	101	21	475	1,058
Total		31	1,618	4,823	11	420	1,050	35	2,038	5,873
irst										
	fall	20	561	2,037	11	502	2,100	20	1,063	4,137
d	winter	11	1,206	4,359	4	32	125	12	1,238	4,484
	spring	19	330	2,758	10	1,509	1,657	20	1,839	4,415
omb.	summer	24	650	3,712	6	305	570	26	955	4,282
Total		41	2,747	12,866	16	2,348	4,452	41	5,095	17,318

tal figure accounts for only one occurrence of each species.

greater in all seasons, number of specimens was larger in all seasons except spring, and mass was greater in all seasons except fall. The seasonal patterns for the individual years were quite similar to the preceding.

The surf zone and tidal pool are related, but quite different habitats. Their ecological relationship can be described as that of a severe, but seasonally relatively stable, environment (the surf zone) with a depauperate fauna which "regularly" contributes segments of its populations in a partly random fashion to a transient, unstable environment (the tidal pool) which reappears at predictable intervals unless certain conditions, whose appearances are largely unpredictable, intervene.

Analysis of Abundance of Fishes

Abundance in terms of numbers of species and specimens and total weight per collection was analyzed by season, year, and sampling location. A two-factor randomized complete-block design was used as the experimental model for each of the dependent variables of interest: number of species, number of specimens, and total weight of fishes per collection. Analysis of variance was employed for each of the three dependent variables in testing the null hypothesis that the effects of sampling location (factor 1, 2 levels; surf, tidal pool), season (factor 2, 4 levels; fall, winter, spring, summer), interaction between sampling location and season, and year (block, 2 levels; October 1969 through September 1970, October 1970 through September 1971) were nonsignificant. Throughout "nonsignificant" means $P > 0.05$; "significant," $0.01 < P < 0.05$; and "highly significant," $P < 0.01$. The number of collections (observations) made for the various treatment combinations was:

	Fall	*Winter*	*Spring*	*Summer*
Year 1:				
Surf	6	7	6	6
Tidal pool	5	4	4	5
Year 2:				
Surf	6	6	7	6
Tidal pool	5	3	6	3

It should be noted that the surf and tidal pool collections made on 10 October 1971 (the start of a third year) were not included in these analyses. Because the cell frequencies were unequal, an unweighted-means analysis was used as the computational procedure with the harmonic mean ($\bar{n}_h = 4.97$) of the number of observations being used as the effective number of observations per cell for computation of main effects and interactions (Winer 1962).

One of the underlying assumptions of the analysis of variance is that of homogeneity of variance. Each set of data was examined for correlation between treatment means and their within-treatment variances. This examination suggested transformations producing homogeneity. An analysis of variance was then conducted.

The within-cell means and variances of the number of species per collection for the various treatment combinations were examined for correlations, but none were
found. The within-cell variances for the number o
species per collection ranged from 0.25 to 6.97. Bartl
test for homogeneity of variance gave a χ^2 value of 1
for 15 df which was not significant. We then proceede
with the analysis of variance on the original data, $X =$
number of species of fishes per collection.

Similar examinations were conducted for the nu
of specimens and total weight of fishes per collection. I
both cases it was apparent that the variances
proportional to the means and were also heterogene
Bartlett's test was employed to test the hypothesis
equal within-cell variances for both the number
specimens and total weight of fishes per collection.
results of Bartlett's test were $\chi^2_{15df} = 93.19$
$\chi^2_{15df} = 99.78$, respectively. Both χ^2 values were highl
significant and we therefore rejected the hypothesis
homogeneity. It appeared that the heterogeneity wa
the regular type for both the number of specimens
total weight of fishes per collection, i.e., the variabilit
within the several treatments was proportional to th
treatment means. For this reason the logarith
transformation, log $(X + 1)$, was used to make the m
and variances independent and to stabilize the withi
cell variances. The logarithmic transformation was m
on the number of specimens of fishes per collection,
Bartlett's test was conducted to determine if
transformation homogenized the variances. The result
Bartlett's test on the within-cell variances for $X =$
(number of specimens of fishes per collection + 1)
$\chi^2_{15df} = 13.78$. Since this was nonsignificant and
appeared that no relationship remained between t
means and variances of the transformed data, we
conducted the analysis of variance on the transfor
data, $X =$ log (number of specimens of fishes per colle
tion + 1). The logarithmic transformation was also u
for the total weight of fishes per collection. Bartlett's
resulted in $\chi^2_{15df} = 12.85$ for the within-cell varianc
the transformed data. This was nonsignificant and t
analysis of variance was then conducted on
transformed data, $X =$ log (total weight of fishes
collection + 1).

The results of the analysis of variance for the numb
of species of fishes per collection (Table 7) indicate
the block or year effect is not significant. The nonsig
cant location-by-season interaction shown in Table 7
dicates that the surf and tidal pool differences in num
of species per collection are constant across season.
location-by-season means of number of species of fi

Table 7.—Analysis of variance of X = number of species of fishes collection. (* Significant, $P < 0.05$; ** highly significant, $P < 0.0$ not significant, $P > 0.05$.)

Source	SS	df	MS	*F*
Blocks (years)	4.92	1	4.92	1.24
Location	124.85	1	124.85	31.66
Season	39.60	3	13.20	3.348
Location by season	17.04	3	5.68	1.441
Error	299.61	76	3.94	
Total	486.02	84		

uently utilized (Maksimov 1972). Northeast of zil, however, Maksimov found that shallower dwell-angids and mackerels were frequently consumed, with *Alepisaurus*.

lepisaurus spp.—In the western North Atlantic, ch (1964) reported findings similar to ours: pidids, sternoptychids, and alepisaurids were the t frequently occurring fishes. The midwater myc-s, gonostomatids, stomiatids, and chauliodontids e observed, however, either occurred infrequently ere completely absent.

he most important food organisms in *Alepisaurus* he Indian Ocean (Parin et al. 1969) were fishes of milies Sternoptychidae (*Sternoptyx diaphana*), midae, Alepisauridae, Nomeidae, Paralepididae, and npylidae. Myctophidae, Gonostomatidae, and other that make daily vertical migrations were missing. suggested that *Alepisaurus* feeds in the depths veen the daytime and nighttime accumulation levels igrating fishes, and passage of these interzonal pop-s may be quite rapid through the depths where *episaurus* were located, explaining the paucity of ically migrating organisms.

he southeastern Pacific, epipelagic fishes were frequently eaten by *Alepisaurus* than midwater s (Haedrich and Nielsen 1966), although some per living fishes such as *Dolichopteryx* were also oc-lly present. *Alepisaurus* stomachs from Suruga apan, contained fishes from surface, midwater, bottom zones (Kubota and Uyeno 1969; Kubota). The four dominant fishes in both studies were *beryx japonicus*, *Lophius litulon*, *Trichiurus lep-* and *Engraulis japonica*. In *Alepisaurus* from New donia (Grandperrin and Legand 1970), the most uently consumed fishes were *Diplospinus mul-tus* (30%) and *Sternoptyx diaphana* (24%). opods were present in 15% of the stomachs, taceans in 10%, and annelids in 12%, most often in *Alepisaurus* specimens.

t studies on tuna food have been limited either to tive analysis or to quantitative analysis based on latively small number of stomach samples from a l area. The accumulation of such data has made t the currently acknowledged opportunistic ing pattern in tunas. A better understanding of inter-ific differences in forage utilization might be met h large-scale quantitative analyses of tuna forage parison with in situ fauna and oceanographic con-ons; there seems little need, however, for additional litative studies of tuna food in the future.

ACKNOWLEDGMENTS

hank James L. Squire and Peter C. Wilson for per-g Gibbs and Collette to participate in longline ses on the *Delaware* to collect tunas and stomach ents. Eugene L. Nakamura advised us on ways of ing the stomach contents. Ray S. Birdsong sorted of the first fishes out of the stomach contents. Daniel M. Cohen, George C. Miller, William D. Anderson, Robert H. Gibbs, Jr., Arthur W. Kendall, Jr., David G. Smith, James C. Tyler, Theodore W. Pietsch, and others identified fishes. Thomas E. Bowman and Clyde Roper assisted in the identification of amphipods and cephalopods respectively. Keiko Hiratsuka Moore assisted with the figures and Terry L. Sayers typed the manuscript and tables. Alexander Dragovich offered useful suggestions during the preparation of this paper. Drafts of the manuscript were read by Daniel M. Cohen, Robert H. Gibbs, Jr., C. C. Lu, Eugene L. Nakamura, Thomas C. Potthoff, and Austin B. Williams.

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ndix Table 1.—Forage components of *Thunnus* and *Alepisaurus*. (A) eaten by *Alepisaurus*; (T) eaten by *Thunnus*; (A*) addition to forage list of Haedrich (1964); (T*) addition to forage list of Dragovich (1969).

Arthropoda
Crustacea
oclass Copepoda (T)
er Calanoida
Family Aetideidae
Euchirella sp. (T*)
Family Candaciidae
Candacia sp. (T*)
ass Malacostraca
er Isopoda (A) (T)
Suborder Flabellifera
Family Cirolanidae
Cirolana sp. (T*)
Family Cymothoidae
Ceratothoa sp. (T*)
Suborder Valvifera
Family Idoteidae
Idotea sp. (T)
er Amphipoda
Suborder Hyperiidea (A) (T)
Family Lanceolidae
Lanceola sp. (A) (T)
Family Vibiliidae
Vibilia sp. (A*) (T)
Family Hyperiidae
Hyperia galba (A*) (T)
Parathemisto gaudichaudii (A*) (T)
Family Phronimidae
Phronima sp. (A) (T)
Phronima atlantica (incl. *solitaria*) (A) (T)
Phronima sedentaria (A) (T)
Family Phrosinidae
Phrosina semilunata (A) (T)
Family Lycaeidae
Brachyscelus crusculum (A) (T)
Lycaea serrata (A*)
Family Oxycephalidae
Oxycephalus clausi (A*)
Family Platyscelidae
Platyscelus ovoides (A) (T)
er Stomatopoda (larva) (T)
Lysiosquilla (larva) (A*) (T)
rder Euphausiacea (A) (T)
Meganyctiphanes norvegica (A*) (T)
er Decapoda (larva and adult) (A) (T)
Superfamily Penaeidea (A*) (T)
Cerataspis petiti (larva) (T)
Superfamily Caridea (larva) (A*) (T); (adult) (T)
Hippolyte zostericola (T*)
Notostomus sp. (T*)
Periclimenes (Harpilius) americanus? (T*)
Family Scyllaridae (larva) (A) (T)
Scyllarides sp. (T)
Scyllarus sp. (A*) (T)
Superfamily Nephropsidea (larva) (T)
Section Anomura (larva) (T)
Family Diogenidae (larva) (A*) (T)
Paguristes ? (larva) (A*) (T)
Section Dromiacea (larva) (A*) (T)
Section Brachyura (larva) (A) (T); (adult) (T)
Family Portunidae (T)
Portunus sayi (T*)

Mollusca
Gastropoda (A) (T)
rder Heteropoda (A) (T)
Family Atlantidae
Atlanta peronii (A)
Oxygyrus keraudrenii (A)
Family Carinariidae
Carinaria lamarcki (A) (T)
Cardiapoda placenta (A)
Family Pterotracheidae
Pterotrachea hippocampus (A)
Pterotrachea scutata (A)
Pterotrachea coronata (A)
Order Pteropoda (A) (T)
Family Cavoliniidae
Cavolina tridentata (A) (T)
Cavolina uncinata (A)
Cavolina gibbosa (A)
Cavolina trispinosa (A)
Family Pneumodermatidae
Pneumoderma atlanticum (A)
Order Nudibranchia
Family Phylliroidae
Phyllirhoe sp. (A*)
Class Cephalopoda (A) (T)
Order Teuthoidea
Suborder Oegopsida (A) (T)
Family Gonatidae (T)
Gonatus fabricii (T)
Family Enoploteuthidae (T)
Abraliopsis sp. (A)
Enoploteuthis sp. (A*) (T*)
Enoploteuthis anapsis (A*)
Pterygioteuthis giardi (A*)
Family Onychoteuthidae (A) (T)
Onychoteuthis sp. (T)
Onykia ? sp. (T)
Family Lepidoteuthidae (T)
Tetronychoteuthis dussumieri (T*)
Family Brachioteuthidae (A*) (T)
Brachioteuthis riisei (A*) (T)
Family Histioteuthidae (A*) (T)
Histioteuthis sp. (T)
Histioteuthis elongata (A*)
Family Bathyteuthidae (A)
Bathyteuthis abyssicola (A*)
Family Ommastrephidae (A) (T)
Hyaloteuthis pelagica (T*)
Illex sp. (A*) (T)
Ommastrephes spp. (A*) (T)
Ommastrephes caroli (T*)
Ornithoteuthis antillarum (T*)
Family Thysanoteuthidae (T)
Thysanoteuthis rhombus (T*)
Family Cranchiidae (A) (T)
Cranchia scabra (T)
Leachia sp. (A*) (T*)
Megalocranchia ? sp. (A)
Order Octopoda (A) (T)
Family Bolitaenidae
Eledonella pygmaea (A*) (T*)
Family Alloposidae
Alloposus mollis (A*) (T)
Family Ocythoidae
Ocythoe tuberculata (T)
Family Octopodidae
Octopus sp. (A*) (T)
Danoctopus schmidti (A*)
Scaeurgus unicirrhus (A*) (T*)
Family Argonautidae
Argonauta sp. (A) (T)
Argonauta argo (A) (T*)

Phylum Coelenterata
Class Scyphozoa (Medusae) (A) (T)

Appendix Table 1.—Forage components of *Thunnus* and *Alepisaurus*. (A) eaten by *Alepisaurus*; (T) eaten by *Thunnus*; (A*) addition to list of Haedrich (1964); (T*) addition to forage list of Dragovich (1969).—Continued.

- Class Hydrozoa
  - Order Siphonophora (A*)

- Phylum Annelida
- Class Polychaeta
  - Family Alciopidae
    - *Greeffia* sp. (A*)
    - *Vanadis* sp. (A*)

- Phylum Chordata
  - Subphylum Tunicata
    - Salpida (A) (T)
- Class Osteichthyes
  - Order Anguilliformes
    - Family Muraenidae
      - *Uropterygius diophus* (A*)
    - Family Ophichthidae
      - *Myrophis punctatus* (T*)
      - *Pisodonophis cruentifer* (A*)
    - Family Nemichthyidae (T)
      - *Nemichthys scolopaceus* (T)
  - Order Clupeiformes
    - Family Clupeidae (T)
  - Order Salmoniformes
    - Family Argentinidae (A)
    - Family Gonostomatidae (A) (T)
      - *Gonostoma* sp. (A) (T)
      - *Maurolicus* sp. (T)
    - Family Sternoptychidae (A) (T)
      - *Argyropelecus aculeatus* (A) (T)
      - *Sternoptyx diaphana* (A) (T)
    - Family Stomiatidae (T)
      - *Eustomias* sp. (T*)
    - Family Aulopidae (T)
      - *Aulopus nanae* (T*)
    - Family Paralepididae (A) (T)
      - *Lestidiops* sp. (T*)
      - *Lestidiops affinis* (A)
      - *Lestidium atlanticum* (A) (T*)
      - *Macroparalepis* sp. (A)
      - *Notolepis rissoi* (T)
      - *Paralepis* sp. (T)
      - *Paralepis atlantica* (A)
      - *Paralepis coregonoides* (A) (T)
      - *Paralepis elongata* (A) (T*)
      - *Stemonosudis* sp. (T*)
    - Family Omosudidae (A) (T)
      - *Omosudis lowei* (A) (T)
    - Family Alepisauridae (A) (T)
      - *Alepisaurus* sp. (A) (T)
      - *Alepisaurus brevirostris* (A) (T*)
      - *Alepisaurus ferox* (A) (T)
    - Family Anotopteridae (A) (T)
      - *Anotopterus pharao* (A) (T)
    - Family Myctophidae (A) (T)
      - *Gonichthys coccoi* (T*)
      - *Lampanyctus* sp. (A)
  - Order Lophiiformes
    - Family Lophiidae (A)
      - *Lophius americanus* (A)
    - Family Antennariidae (A) (T)
      - *Antennarius radiosus* (A) (T)
    - Family Ogcocephalidae (A) (T)
      - *Dibranchus atlanticus* (T*)
      - *Halieutichthys aculeatus* (A)
    - Suborder Ceratioidei
      - Family Ceratiidae
        - *Borophryne* sp. (T*)
      - Family Linophrynidae (T*) (A)
        - *Linophryne* sp. (T*) (A)
  - Order Gadiformes
    - Family Moridae
      - *Laemonema barbatula* (A*)
    - Family Bregmacerotidae (A)
      - *Bregmaceros* sp. (A)
    - Family Gadidae (A) (T)
      - *Melanogrammus aeglefinus* (A) (T*)
      - *Merluccius bilinearis* (T)
  - Order Atheriniformes
    - Family Belonidae (T)
      - *Tylosurus acus* (T*)
    - Family Scomberesocidae (T)
      - *Scomberesox saurus* (T)
    - Family Exocoetidae (T)
      - *Cypselurus* sp. (T)
      - *Cypselurus heterurus* (T)
      - *Exocoetus obtusirostris* (T)
    - Family Hemiramphidae
      - *Hyporhamphus* sp. (T)
  - Order Beryciformes
    - Family Melamphaidae (T*)
    - Family Anoplogasteridae (A) (T)
      - *Anoplogaster cornutus* (A) (T)
    - Family Monocentridae (T*)
    - Family Holocentridae (T)
      - *Holocentrus* sp. (T)
      - *Holocentrus ascensionis* (T)
  - Order Zeiformes
    - Family Caproidae (T)
      - *Antigonia capros* (T)
      - *Capros aper* (T)
  - Order Lampridiformes
    - Family Lophotidae (T*)
    - Family Trachipteridae (A) (T)
      - *Trachipterus* sp. (A) (T)
  - Order Gasterosteiformes
    - Family Fistulariidae (T)
      - *Fistularia* sp. (T)
    - Family Syngnathidae (A) (T)
      - *Hippocampus* sp. (T)
      - *Hippocampus erectus* (A) (T*)
  - Order Scorpaeniformes
    - Family Scorpaenidae (A)
    - Family Triglidae
      - *Peristedion gracile* (T)
      - *Peristedion greyae* ? (T)
      - *Peristedion miniatum* (T)
  - Order Dactylopteriformes
    - Family Dactylopteridae (T)
      - *Dactylopterus volitans* (T)
  - Order Perciformes
    - Family Serranidae (A) (T)
      - *Serranus* sp. (T*)
    - Family Priacanthidae (T)
      - *Cookeolus boops* (T*)
      - *Pseudopriacanthus* sp. (T)
    - Family Echeneidae (T)
      - *Remora osteochir* (T*)
    - Family Carangidae (T)
      - *Caranx* sp. (T)
      - *Selar crumenophthalmus* (T)
      - *Seriola dumerili* (T*)
      - *Seriola rivoliana* (T*)
      - *Trachurus* sp. (T)
      - *Trachurus lathami* (T)
      - *Vomer setapinnis* (T)
    - Family Coryphaenidae (T)
      - *Coryphaena equiselis* (T*)
      - *Coryphaena hippurus* (T)

endix Table 1.—Forage components of *Thunnus* and *Alepisaurus*. (A) eaten by *Alepisaurus*; (T) eaten by *Thunnus*; (A*) addition to forage list of Haedrich (1964); (T*) addition to forage list of Dragovich (1969).—Continued.

- Family Bramidae (T)
  - *Collybus drachme* (T)
  - *Pteraclis* sp. (A) (T)
  - *Pterycombus* sp. (A) (T)
  - *Taractes* sp. (T)
- Family Lutjanidae (A) (T)
  - *Pristipomoides* sp. (A) (T)
  - *Pristipomoides aquilonurus* (T)
- Family Chaetodontidae (T)
  - *Centropyge argi* (T*)
- Family Pomacentridae (T*)
- Family Trichodontidae (T*)
- Family Uranoscopidae (A)
  - *Kathestoma averruncus* (A)
- Family Chiasmodontidae (T)
  - *Pseudoscopelus* sp. (T*)
- Family Acanthuridae (A) (T)
  - *Acanthurus chirurgus* (T)
  - *Acanthurus coeruleus* (T)
- Suborder Scombroidei (A) (T)
  - Family Gempylidae (A) (T)
    - *Diplospinus multistriatus* (A) (T*)
    - *Gempylus serpens* (T)
    - *Nealotus* sp. (A)
    - *Nealotus tripes* (A) (T*)
    - *Nesiarchus nasutus* (A) (T)
  - Family Trichiuridae (T)
  - Family Scombridae (A) (T)
    - *Auxis* sp. (A) (T)
    - *Euthynnus alletteratus* (T)
    - *Katsuwonus pelamis* (T)
    - *Scomber japonicus* (A*) (T)
    - *Thunnus atlanticus* (T)
  - Family Xiphiidae
    - *Xiphias gladius* (T*)
- Suborder Stromateoidei (A) (T)
  - Family Stromateidae (A)
    - *Peprilus triacanthus* (A)
  - Family Centrolophidae (A) (T)
    - *Hyperglyphe* sp. (T*)
    - *Hyperglyphe perciformis* (A) (T)
  - Family Nomeidae (A) (T)
    - *Nomeus* sp. (A) (T)
    - *Psenes maculatus* (T*)
    - *Psenes pellucidus* (A) (T*)
  - Family Tetragonuridae (A) (T)
    - *Tetragonurus cuvieri* (A) (T)
- Order Pleuronectiformes
  - Family Bothidae (A) (T)
- Order Tetraodontiformes
  - Suborder Balistoidei (T)
    - Family Balistidae (incl. Monacanthidae) (A) (T)
      - *Aluterus* sp. (T)
      - *Balistes* sp. (T)
      - *Balistes capriscus* (T)
      - *Cantherhines* sp. (T)
      - *Canthidermis* sp. (T)
      - *Canthidermis maculatus* (T*)
      - *Monacanthus* sp. (T*)
      - *Monacanthus ciliatus* (T)
      - *Monacanthus hispidus* (T*)
      - *Monacanthus tuckeri* (A) (T)
      - *Xanthichthys ringens* (T)
    - Family Tetraodontidae (A) (T)
      - *Lagocephalus* sp. (T)
      - *Sphoeroides* sp. (T)
    - Family Diodontidae (T)
      - *Chilomycterus* sp. (T*)
      - *Diodon* sp. (T)
    - Family Molidae (T)
      - *Mola mola* (T*)
      - *Ranzania laevis* (T*)

Appendix Table 2.—Precent frequency of occurrence of food fish categories identified from 266 stomachs of western North Atlantic *Thunnus albacares* by size range.

Food fish categories	Size (cm FL): No. of specimens:	60.0-99.9 58	100.0-119.9 90	120.0-169.9 63	Unknown 55	Total 266
Sternoptychidae (unid.)					3	< 1
Sternoptyx diaphana			1			< 1
Aulopidae						
Aulopus nanae			1			< 1
Paralepididae (unid.)			1	5		2
Omosudidae						
Omosudis lowei					2	< 1
Alepisauridae						
Alepisaurus brevirostris				3		1
A. ferox				2		< 1
Ogcocephalidae (unid.)		3	1	4		2
Halieutichthys aculeatus					2	< 1
Ceratioidei (unid.)			1			< 1
Ceratiidae						
Borophryne sp.					2	< 1
Gadidae						
Melanogrammus aeglefinus			1			< 1
Belonidae						
Tylosurus acus		2				< 1
Exocoetidae					4	1
Cypselurus sp.					2	< 1
C. heterurus					2	< 1
Exocoetus obtusirostris					2	< 1
Hemiramphidae						
Hyporhamphus sp.					2	< 1
Scomberesocidae						
Scomberesox saurus			2	2		1
Anoplogasteridae						
Anoplogaster cornutus		2			4	1
Holocentridae (unid.)			13	8		6
Holocentrus sp.			2			1
H. ascensionis					2	< 1
Caproidae						
Antigonia capros		3				1
Fistulariidae						
Fistularia sp.					2	< 1
Syngnathidae (unid.)			4	2		2
Hippocampus sp.		5	6	11	2	6
H. erectus		2	2	14		5
Triglidae						
Peristedion greyae			1		1	1
P. gracile			1			< 1
P. miniatum				2		< 1
Dactylopteridae						
Dactylopterus volitans			2	2		1
Perciformes (unid.)		2				< 1
Serranidae (unid.)		2	1			1
Priacanthidae						
Cookeolus boops		16	10	5		9
Pseudopriacanthus sp.					3	< 1
Echeneidae						
Remora osteochir		3				1
Carangidae (unid.)		5	7	3		4
Caranx sp.		7	20	11		11
Selar crumenophthalmus		5	2			2
Seriola dumerili					2	< 1
S. falcata					4	1
Trachurus sp.		7	2			2
Vomer setapinnis		3	6	6		4

Appendix Table 2.—Percent frequency of occurrence of food fish categories identified from 266 stomachs of western North Atlantic *Thunnus albacares* by size range.—Continued.

Food fish categories Size (cm FL):	60.0-99.9	100.0-119.9	120.0-169.9	Unknown	Total
No. of specimens:	58	90	63	55	266
Coryphaenidae					
Coryphaena equiselis			3	2	1
Coryphaena hippurus	2	6	6	4	5
Bramidae (unid.)	3	1	2		2
Collybus drachme	5	2	6		3
Pteraclis sp.				4	1
Pterycombus sp.	26	13	3		11
Taractes sp.				3	< 1
Lutjanidae					
Pristipomoides sp.		1			< 1
Chaetodontidae (unid.)	10	1	2		3
Centropyge argi	5	1	2		2
Chiasmodontidae (unid.)				11	2
Pseudoscopelus sp.	16	11	3		8
Acanthuridae (unid.)	9	7	2		5
Acanthurus coeruleus				4	1
Acanthurus chirurgus				2	< 1
Trichiuridae (unid.)		1			< 1
Gempylidae (unid.)			2		< 1
Diplospinus multistriatus				6	2
Gempylus serpens				3	1
Nealotus tripes				3	1
Neasiarchus nasutus				2	< 1
Scombridae					
Auxis sp.	5	3	8	7	5
Euthynnus alletteratus			2		< 1
Katsuwonus pelamis	2	4			2
Thunnus atlanticus			2		< 1
Xiphiidae					
Xiphias gladius			2		< 1
Stromateoidei (unid.)		2	2		2
Nomeidae (unid.)	2	1			1
Tetragonuridae					
Tetragonurus cuvieri		1			< 1
Bothidae (unid.)	2				< 1
Tetraodontiformes (unid.)	3	3			2
Balistoidei (unid.)		3	3		2
Balistidae (including Monacanthidae)	19	24	27	3	12
Aluterus sp.			3	5	2
Balistes sp.		1	10	3	3
Balistes capriscus	2	2		9	3
Cantherhines sp.			2		< 1
Canthidermis sp.	5	1			2
Canthidermis maculatus	2				< 1
Monacanthus sp.		6	17	5	7
Monacanthus ciliatus			2		< 1
Monacanthus hispidus				3	< 1
Xanthichthys ringens		2	3		2
Tetraodontidae (unid.)	5	2			2
Lagocephalus sp.			5	4	2
Sphoeroides sp.	3	8			3
Diodontidae					
Diodon sp.	2	2	3	2	2
Molidae (unid.)	2				< 1
Mola mola			2		< 1
Ranzania laevis	2	6		2	3
Unidentified fishes	21	17	25	67	30

Appendix Table 3.—Percent frequency of occurrence of food fish categories in 38 stomachs of western North Atlantic *Thunnus alalunga* by size range.

Food fish categories	Size (cm FL): No. of specimens:	80.0-99.9 13	100.0-110.0 15	Unknown 10	Total 38
Sternoptychidae					
Sternoptyx diaphana			7		3
Paralepididae (unid.)			7	30	11
Omosudidae					
Omosudis lowei				20	5
Alepisauridae				20	5
Myctophidae				10	3
Ogcocephalidae (unid.)		8			3
Caproidae					
Antigonia capros				10	3
Triglidae					
Peristedion gracile		8			3
Perciformes (unid.)		8			3
Serranidae (unid.)			7		3
Carangidae					
Vomer setapinnis			7		3
Bramidae					
Collybus drachme				10	3
Pteraclis sp.				30	8
Pterycombus sp.			23		8
Chaetodontidae (unid.)		8			3
Pomacentridae (unid.)				10	3
Chiasmodontidae				10	3
Acanthuridae				20	5
Gempylidae				10	3
Diplospinus multistriatus				30	8
Nealotus tripes				10	3
Nesiarchus nasutus				10	3
Scombridae					
Auxis sp.		15			5
Scomber japonicus		8			3
Nomeidae					
Psenes pellucidus			7		3
Bothidae		8			3
Tetraodontidae		8		10	5
Diodontidae					
Chilomycterus sp.			7		3
Unidentified fishes		77	67	40	63

ppendix Table 4.—Percent frequency of occurrence of food fish categories in 38 stomachs of western North Atlantic *Thunnus thynnus*.

Food fish categories	% freq.	Food fish categories	% freq.
chthidae		Bramidae	
yrophis punctatus	3	*Collybus drachme*	8
ptychidae		*Pteraclis* sp.	5
ropelecus aculeatus	3	*Taractes* sp.	8
uridae		Trichiuridae	3
lepisaurus sp.	8	Scombridae	
topteridae		*Auxis* sp.	8
opterus pharao	5	Balistidae (incl. Monacanthidae)	
eresocidae		*Aluterus* sp.	3
mberesox saurus	5	*Monacanthus hispidus*	5
plogasteridae		*Xanthichthys ringens*	3
plogaster cornutus	5	Tetraodontidae	
idae	3	*Sphoeroides* sp.	5
thidae		Diodontidae	5
ippocampus erectus	8	Molidae	
angidae	3	*Mola mola*	6
		Unidentified fishes	37

ppendix Table 5.—Percent frequency of occurrence of food fish categories in 81 stomachs of western North Atlantic *Alepisaurus*.

Food fish categories	% freq.	Food fish categories	% freq.
hthidae		Moridae	
donophis cruentifer	1	*Laemonema barbatula*	4
raenidae		Anoplogasteridae	
ropterygius diopus	1	*Anoplogaster cornutus*	2
inidae	1	Trachipteridae	
omatidae		*Trachipterus* sp.	1
ostoma sp.	1	Syngnathidae	
noptychidae		*Hippocampus erectus*	6
ropelecus aculeatus	2	Scorpaenidae	2
noptyx diaphana	25	Serranidae	2
dae		Carangidae	
ulopus nanae	2	*Trachurus lathami*	1
alepididae	5	*Vomer setapinnis*	1
idium affine	1	Bramidae	2
idium atlanticus	1	*Pteraclis* sp.	4
roparalepis sp.	4	*Pterycombus* sp.	5
otolepis rissoi	5	Lutjanidae	1
ralepis sp.	6	*Pristipomoides* sp.	1
lepis brevirostris	4	Uranoscopidae	
lepis coregonoides	33	*Kathestoma averruncus*	1
aralepis elongata	4	Acanthuridae	1
osudidae	2	Gempylidae	1
osudis lowei	1	*Diplospinus multistriatus*	14
auridae		*Neolotus* sp.	1
pisaurus sp.	4	*Neolotus tripes*	7
lepisaurus brevirostris	5	*Nesiarchus nasutus*	5
lepisaurus ferox	4	Scombridae	
pteridae		*Auxis* sp.	1
topterus pharao	1	*Scomber japonicus*	2
ctophidae		Stromateidae	2
ampanyctus sp.	1	*Peprilus triacanthus*	1
dae		Centrolophidae	
hius americanus	1	*Hyperglyphe perciformis*	4
nariidae		Nomeidae	
ntennarius radiosus	6	*Nomeus* sp.	2
cocephalidae	1	*Psenes pellucidus*	2
ieutichthys aculeatus	2	Tetragonuridae	
hrynidae		*Tetragonurus cuvieri*	1
inophryne sp.	2	Bothidae	2
egmacerotidae		Balistidae	1
gmaceros sp.	1	*Monacanthus tuckeri*	1
lae		Tetraodontidae	2
lanogrammus aeglefinus	5		

Appendix Table 6.—Percent frequency of occurrence of principal invertebrate groups in 215 stomachs of western North Atlantic *Thunnus albacares* by size range.

Food categories	Size (cm FL): No. of specimens:	60.0-99.9 59	100.0-119.9 91	120.0-169.9 65	Total 215
Portunidae		12	7	15	11
Brachyura larvae		8	10	5	8
Anomura larvae		19	14	2	12
Cerataspis larvae		5	7	3	5
Scyllaridae (incl. larvae)			3	2	2
Other Decapoda (incl. larvae)		12	8	5	8
Stomatopoda larvae		17	20	3	14
Euphausiacea		5			1
Phrosina semilunata		29	16	17	20
Phronima spp.		12	15	17	15
Other Hyperiidea		15	9	11	11
Isopoda		2	3		2
Copepoda		2	2	3	2
Heteropoda		10	10	11	10
Pteropoda					< 1
Other Gastropoda		3			
Cephalopoda		83	77	82	80

Appendix Table 7.—Percent frequency of occurrence of principal invertebrate groups in 34 stomachs of western North Atlantic *Thunnus alalunga* by size range.

Food categories	Size (cm FL): No. of specimens:	80.0-99.9 15	100.0-110 19	Total 34
Brachyura larvae		20	5	12
Anomura larvae		13		6
Scyllaridae (incl. larvae)		7	11	9
Other Decapoda (incl. larvae)		20	37	29
Stomatopoda larvae		13	47	32
Euphausiacea		7	11	9
Phrosina semilunata		60	68	65
Phronima spp.		7	10	9
Other Hyperiidea		20	26	24
Cephalopoda		93	84	89

Appendix Table 8.—Percent frequency of occurrence of principal invertebrate groups in 27 stomachs of western North Atlantic *Thunnus thynnus* by size range.

Food categories	Size (cm FL): No. of specimens:	100.0-149.9 10	150.0-199.9 10	200.0-231.9 7	Total 27
Other Decapoda (incl. larvae)			20	14	11
Euphausiacea		10	10	14	11
Phrosina semilunata			50	14	22
Phronima spp.		10	30		15
Other Hyperiidea		10	40	14	22
Heteropoda; Pteropoda		70	50	29	52
Cephalopoda		90	90	71	85

Appendix Table 9.—Percent frequency of occurrence of principal invertebrate groups in 81 stomachs of western North Atlantic *Alepisaurus* spp.

Food categories	% freq.
Brachyura larvae	23
Anomura larvae	22
Scyllaridae (larvae)	5
Other Decapoda (incl. larvae)	4
Stomatopoda larvae	2
Euphausiacea	17
Phrosina semilunata	60
Phronima spp.	51
Other Hyperiidea	47
Isopoda	1
All Crustacea combined	75
Heteropoda	14
Pteropoda	12
Other Gastropoda	4
Polychaeta	38
Salpa and Pyrosoma	16
Cephalopoda	49
Medusae	6

Appendix Table 10.—Occurrence and co-occurrence of crustaceans and cephalopods in the stomachs of western North Atlantic *Thunnus* and *Alepisaurus* species.

	Number of exclusive occurrences		Number of co-occurrences	Co-occurrence, estimated average percent-volume	
Species	Crustaceans	Cephalopods		Crustaceans	Cephalopods
T. albacares	28	89	125	31	69
T. alalunga	7	8	30	33	67
T. obesus	1	7	7	21	79
T. thynnus	3	26	14	23	77
Alepisaurus spp.	30	9	31	54	46

Appendix Table 11.—Percent frequency of occurrence of cephalopod groups in stomachs of western North Atlantic *Thunnus* and *Alepisaurus* species.

	T. albacares	*T. alalunga*	*T. obesus*	*T. thynnus*	*Alepisaurus* spp.
Specimens containing cephalopods (Percent of total)	214 (77)	38 (79)	14 (100)	40 (77)	40 (49)
Soft-bodied squids,[1] % with	2	3	0	0	15
Other squids, % with	72	66	86	45	42
Argonauta spp., % with	36	8	0	25	25
Alloposus mollis, % with	5	0	0	48	32
Other octopods, % with	12	32	0	0	32

[1] Bathyteuthidae, Cranchiidae, and Histioteuthidae.

NOAA Technical Report NMFS SSRF-705

Migration and Dispersion of Tagged American Lobsters, *Homarus americanus*, on the Southern New England Continental Shelf

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January 1977

U.S. DEPARTMENT OF COMMERCE
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Migration and Dispersion of agged American Lobsters, *Homarus americanus*, on the Southern New England Continental Shelf

JOSEPH R. UZMANN, RICHARD A. COOPER, and KENNETH J. PECCI [1]

ABSTRACT

An apparently contiguous stock of American lobsters, *Homarus americanus*, is concentrated along the outer continental shelf margin and slope from Corsair Canyon westward and southward to the region of Baltimore Canyon. Between April 1968 and May 1971 we captured, tagged, and released a total of 7,326 lobsters at 52 localities between Corsair Canyon and Baltimore Canyon. As of December 1972, 945 recaptures (12.9% recovery) had been reported, providing a basis for interpretation of seasonal and long-term movements, as well as measurements of growth rate and moult frequency. A classification scheme is developed and applied to distinguish between apparently directed seasonal movements (migrations), localized movements of less than 10 nautical miles (18.5 km), and long-period (>120 days) dispersions of 10 miles or more. This last category includes point to point tracks that cannot be objectively resolved in terms of directionality and may represent random dispersal, a summation of seasonally directed tracks, or both.

We conclude from the track analyses that at least 20% of the offshore lobsters annually engage in directed shoalward migrations in spring and summer with return to the shelf margin and slope in fall and winter. This conclusion is reinforced by independent analysis of the time/depth/temperature associations of tagged lobsters at recapture which, of itself, suggests that an even larger proportion of the offshore lobsters annually effect directed migrations in response to seasonal temperature variations.

INTRODUCTION

ommercial concentrations of American lobsters, *narus americanus*, inhabit the outer continental shelf slope off southern New England and the Middle ntic states southward to Virginia. The history, elopment, and recent status of this resource have n summarized in the collective studies of Firth 0), Schroeder (1955, 1959), McRae (1960), Hughes 3), Saila and Flowers (1968), Skud and Perkins 9), Uzmann (1970), and Cooper and Uzmann (1971). s report is an extension of the last mentioned paper deals further with findings and implications of onal and long-term movements derived from an ex- ive tagging program conducted over the period 1968-

chroeder (1959) defined the offshore lobster popula- as “a population of lobsters, large enough to support mercial fishing off the east coast of the United States g the outer shelf and upper slope between the eastern of Georges Bank and the offing of Delaware Bay. s area at depths of roughly 60-250 fm (110-450 m) is ut 400 miles long and 5-10 miles wide. Lobsters are e plentiful along the eastern half of this stretch than he west and south.”

he offshore lobster fishery, so-called, has rapidly med a role of prominence among the major offshore fisheries of the northwest Atlantic. A brief review of its growth over the past two decades will place it in perspective relative to the long established coastal fishery and indicate its future trend.

Like the coastal stocks from Maine to New Jersey, the offshore stock has sustained a steadily increasing rate of exploitation since the mid-fifties prior to which time it ranked as a minor fishery with the majority of catches taken incidental to trawling for groundfish species. Following World War II, the coastal fishery expanded rapidly to a peak yield in 1960 of 29 million pounds (13.2 million kg) and has since declined measurably despite increased fishing effort; meanwhile, offshore lobster catches increased from nearly 2 million pounds (0.9 million kg) in 1960 to over 8 million pounds (3.6 million kg) in 1970. Ungrouped landings statistics indicate that U.S. lobster production is relatively stable at some 30 million pounds (13.6 million kg) annually, but the fact of the matter is that offshore production has annually offset the decline of coastal landings. From 1968 to 1970 offshore lobster landings averaged over 20% of the U.S. catch.

MATERIALS AND METHODS

The tagging program reported here was conducted as part of the work plan of 14 research cruises over the period 1968-71 during which time a total of 7,326 lobsters were tagged and released at 52 localities along the outer edge of the continental shelf from Corsair Canyon west

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and south to Baltimore Canyon (Fig. 1, Table 1). The lobsters were taken with otter trawls or traps (five localities only) at depths of 35-300 fathoms (64-549 m), then tagged and released within a day after capture and within 2.7 nautical miles (5 km) of the capture site. Tagging methodology has been described previously by Cooper (1970). Essentially, the tag consists of coded polyvinyl chloride tubing with a polyethylene monofilament leader and stainless steel anchor implanted in the right or left dorsal extensor muscle below the carapace. The anchor is inserted with the aid of a hypodermic needle through the connecting membrane between the carapace and the first abdominal segment. The membrane breaks down at ecdysis to permit withdrawal of the lobster from the old exoskeleton and the implanted tag is thus retained through successive molts.

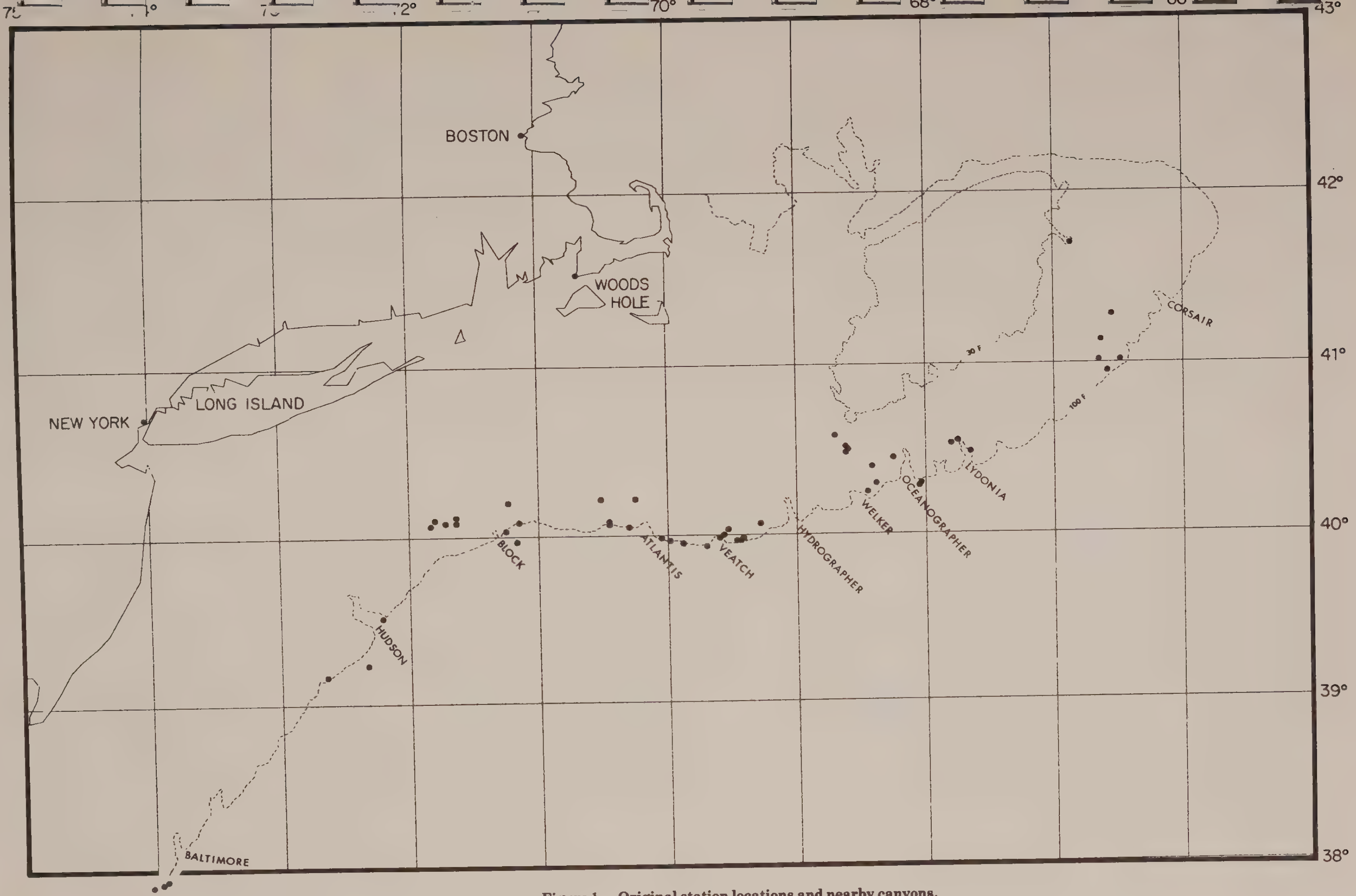
The tagging program and its objectives were initially well advertised with letters and poster notices being sent to all New England and Middle Atlantic state fisheries commissioners, to all vessel captains known to engage in the offshore lobster fishery, and to all major buyers and wholesalers of lobsters. Port agents of the National Marine Fisheries Service were specially briefed and then maintained continuing liaison with the lobster fishermen and dealers.

In a preliminary paper Cooper and Uzmann (1 reported 400 returns from 5,710 releases through 1969 (7.0% reported recapture); in 1970 and 1971 additional releases raised the total number tagged and release 7,326, of which a cumulative total of 945 recoveries had been reported to us as of 15 December 1972. Thus, the accumulated reported recaptures is currently 12.9% and creasing at a decreasing rate annually by virtu natural mortality of the tagged population, tag loss, nonrecognition of tags, possible emigration into areas with little or no commercial fishery, removal and nonrepor by U.S. fishermen and various elements of the for fishing fleet, and possibly, increased incidence of nonreporting because of fishermen apathy. We offer the last theoretical reason because renewed publicity and a crease in the tag return reward from $1.00 to $5.00 in tober 1971 failed to elicit a significant increase in the tag return rate despite a significant input (1,142) of newly tagged lobsters in that calendar year. This hypothes further supported by calculations of expected returns per annum under the condition of exponential decline of the

Table 1.—Summary of offshore lobster tagging, 1968-71: station references, releases, and recaptures.[1]

Year	Composite station number	Original station number(s)	Plot position		Canyon or shelf region	Number of releases	Number of recaptures
			Lat. N	Long. W			
1968	1	(1-3)	40°17′	68°02′	Oceanographer Canyon	42	3
	2	(4)	39°59′	69°36′	Veatch Canyon	13	3
	3	(5)	39°31′	72°13′	Hudson Canyon	146	9
	4	(6)	40°05′	71°09′	Block Canyon	52	7
	5	(7-8)	40°04′	70°27′	Atlantis Canyon	264	29
	6	(9, 11)	39°57′	69°56′	Veatch Canyon	149	22
	7	(10)	39°56′	69°41′	Veatch Canyon	99	10
	8	(12)	39°59′	70°03′	Veatch Canyon	50	4
	9	(13)	40°03′	70°17′	Atlantis Canyon	143	19
	10	(14)	40°13′	70°30′	Atlantis Canyon	39	3
	11	(15)	40°12′	70°15′	Atlantis Canyon	84	6
	12	(16)	40°12′	71°14′	Block Canyon	57	3
	13	(17-19)	40°05′	71°47′	Block Canyon	482	40
	14	(20-21)	40°05′	71°38′	Block Canyon	266	25
	15	(22)	41°42′	66°52′	Leg, Georges Bank	46	10
	16	(23-26)	40°33′	68°39′	SW Georges Bank	479	59
	17	(27-28)	40°31′	67°42′	Lydonia Canyon	223	27
Total						2,634	279
1969	18	(29, 30, 32)	39°59′	69°29′	Veatch Canyon	1,350	213
	19	(31)	40°03′	69°16′	Veatch Canyon	751	104
	20	(33-35)	40°59′	66°34′	Corsair Canyon	387	44
	21	(36)	40°32′	67°47′	Lydonia Canyon	166	23
	22	(37-38)	41°12′	66°35′	Corsair Canyon	422	46
Total						3,076	430
1970	23	(48, 50)	40°16′	68°25′	Oceanographer Canyon	301	34
	24	(49, 51)	40°26′	68°20′	Oceanographer Canyon	173	22
Total						474	56
1971	25	(57-58)	40°00′	71°12′	Block Canyon	60	10
	26	(59, 63)	39°14′	72°20′	Hudson Canyon	54	1
	27	(60-62)	37°55′	73°59′	Baltimore Canyon	194	11
	28	(64)	39°10′	72°38′	Hudson Canyon	29	3
	29	(65-66)	40°00′	69°29′	Veatch Canyon	805	155
Total						1,142	180
Grand Total						7,326	945

[1] The original releases are treated as 29; composites of two or more stations have within-group variation of less than 10 days, 10′ latitude, and 10′ longitude. Original station numbers are shown in parentheses.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NEW YORK
CORSAIR
30 F
100 F
LYDONIA
OCEANOGRAPHER
WELKER
HYDROGRAPHER
VEATCH
ATLANTIS
BLOCK
HUDSON
BALTIMORE

Figure 1.—Original station locations and nearby canyons.

tagged population at a theoretical summed rate of 23% per annum (12% tag loss, 6% natural mortality, 5% recapture). In calendar year 1972, for example, the theoretical number of tagged lobsters outstanding at the beginning of the year was 3,630; the expected number of returns for 1972 based on the average rate of returns (0.049) in years 1968-71 is 179, in sharp contrast to 67 actual returns.

The distribution of recaptured tagged lobsters is considered representative of the distribution of the lobster population. Fishermen search for commercial quantities of lobsters throughout the year at depths of 10-350 fathoms (18-640 m), which is a considerably greater range than the 35-300 fathoms (64-549 m) depth interval from which lobsters for tagging were initially captured.

DATA REDUCTION, PLOTTING, AND FORMAT

Data received on individual recaptures varied considerably. Data sought included date and position of recapture (latitude and longitude, or loran A coordinates), sex, carapace length, presence or absence of external eggs, cheliped configuration, and designation of any missing chelipeds and walking legs. The most critical data were location and date of recapture, and carapace length from which both migration trends and growth could be determined; this was received on 350 of the recaptured lobsters. Recapture location and date only were received on 576 individuals and provide the basis for analysis of movements.

Data was listed and keypunched in two different formats. The data format (see appendix tables) for this study includes growth increments for reader reference, but this element of the study is being treated separately; return data is listed chronologically by sex. The basic data deck provided input for computer calculation for individual recaptures of great circle distance traveled from point of release to point of recapture, days at large, and other standard computations such as mean distance traveled and mean time at large by various groupings of individuals. The same data deck served as input for a Cal-Comp Plotter, Model 663, from which release coordinates, recapture coordinates, or combinations of both were plotted in various combinations to reveal and display the overall features of dispersion within and between release groups and to show the overall monthly distribution of recaptures. The Cal-Comp Plotter was simultaneously programmed and fed a series of coastline coordinates, isobath coordinates, and titular information such that the finished plot was a Mercator chart drawing to the nominal scale of 1:1,200,000.

Among the 945 recaptured lobsters, 584 (61.8%) were reported by specific location, 183 (19.4%) by generalized location—usually by reference to a named submarine canyon, and 178 (18.8%) without location information of any kind. Those recaptures reported by approximate location are hand-plotted in distinctive fashion within the machine plots of the various subgroups of returns with specific location.

In order to facilitate interpretation of recovery data, we have treated the 52 original releases as 29 accordi the constraints footnoted in Table 1. This ac minimized the plotter executions and gave more coherence to the individual plots. Test plots of recovery coordinates showed a number of cases where overplot or tight grouping of recovery points resulted in a co usion of points and numbers. In these instances we used a plotting subroutine which plotted all points withi upon the eastern and southern side of a given 6-mi square (0.1° square) as a single point with collective number at the diagonal center of the square; the average displacement of any single point plotted in this ma is well under 3 nautical miles (5.6 km) which we h accepted as within the limits of navigational accuracy, reporting, or both.

Because the tag releases were effected in greate lesser increments over a long period of time, they stitute a series of repetitive experiments and are treated accordingly; the overall presentation which follows takes the form of an atlas which provides a pictorial analys the results of the various releases. Additionally, we have developed a generalized treatment of the monthly distribution of offshore lobsters in relation to bot temperature.

Original Station Locations

A total of 52 releases of tagged lobsters were mad the outer continental shelf and slope commencing in March 1968 and ending in May 1971 (Table 1). Cruise numbers and station numbers are not wholly in secutive order because interim cruises involving coa area tagging were also conducted in the same period. Thus, station 66 occupied during Cruise 20 was actu lly the 52nd and last release during a total of 14 cruises cerned with offshore tagging.

The original release localities (Fig. 1) show their location relative to major features of the continental s and to each other. Most (86%) of the tagging was complished from the vicinity of Block Canyon eastward because of more productive lobster fishing in these areas and because other aspects of cruise objectives requi cruise orientation to the east of Block Canyon to m imize time sharing of the research vessels *Delaware I*, *Delaware II*, and *Albatross IV*.

Composite Station Locations

Thirteen (25%) of the 52 original releases are plotte their original release locality (Fig. 2). The remain were combined in groups of two or three and assigned location coordinates with averaged latitude and longitude rounded to the nearest whole minute (Table Maximum distance between any two original rele sites comprising a composite station was 4 nautical miles (7.4 km). The purpose of this treatment was to effect a logical pooling of release and recapture information t would expedite both plotting and evaluation of the da Computations of distance traveled and time at large are,

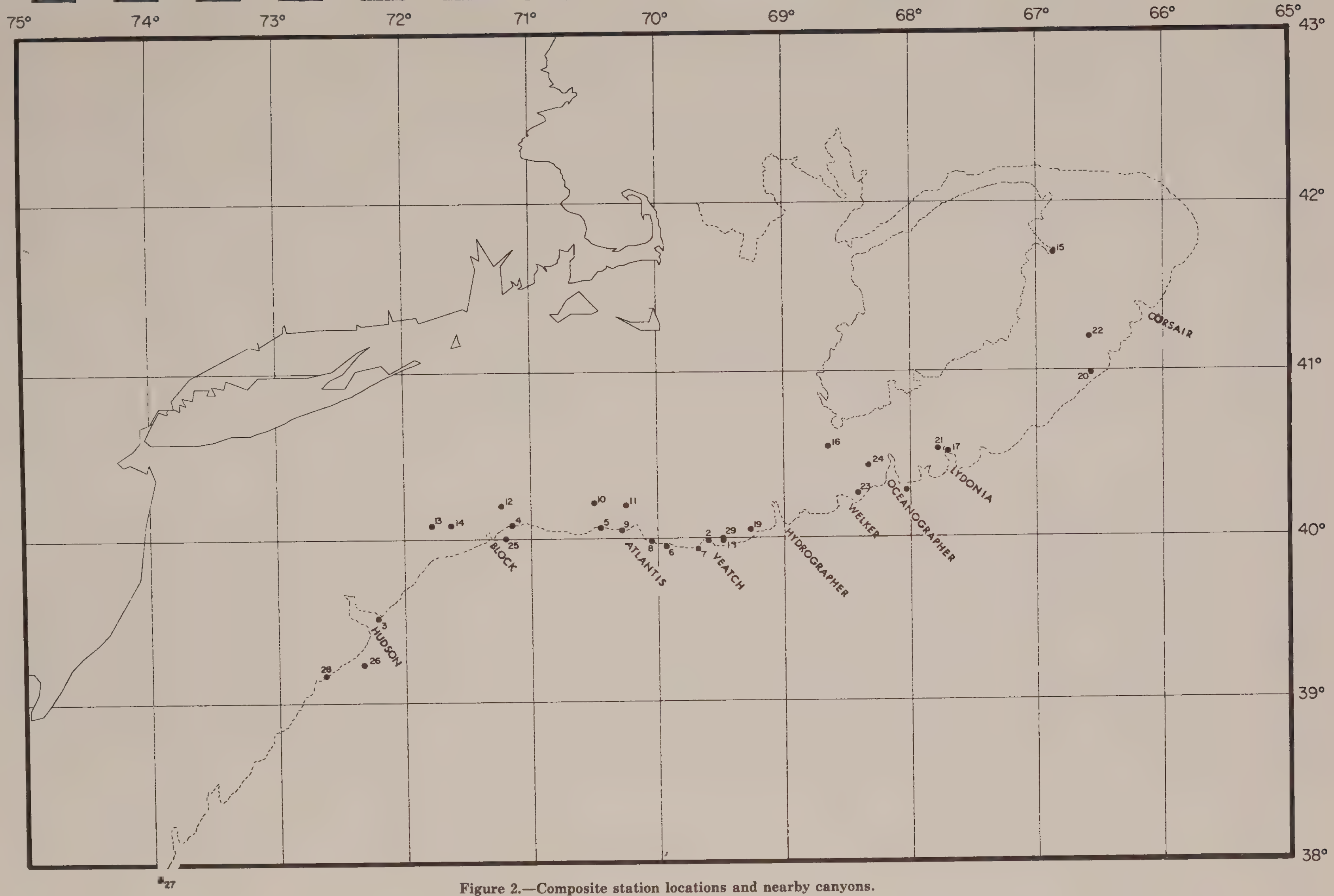
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Figure 2.—Composite station locations and nearby canyons.

however, based on original release locations and dates. Details concerning individual recaptures are referenced to composite station number and listed in the appendix tables of this report.

Composite of Recoveries

Figure 3 is a precision plot of the reported recovery positions of all returns; in Figure 4 the same set of coordinates are grouped by 6-minute squares to permit readable numerical signature and to obviate overplotting of identical recovery coordinates, some of which occurred by chance, with others the result of multiple recaptures by vessels fishing a given area for one or more days.

Comparison of Figure 3 with Figure 1 (original station locations) shows overall dispersion from the original release locations along the edge of the continental shelf. Replotting of these data by release groups (Figs. 5-29) illustrates the magnitude and direction of the individual dispersions.

Straight-line dispersion (point of release to point of recovery) of individual lobsters is shown in Figures 5-29; concentric circles having a radius of 10 and 50 nautical miles (18.5 and 92.7 km) are drawn about each release locality to indicate the magnitude and variability of lobster movements from a given locality. Track lines of 50 miles (92.7 km) or greater are labeled with the return number and sex (F or M). Where two or more recaptures were made at the same reported locality, the solid circle representing the recovery point is appropriately numbered. In several instances (Figs. 20, 21, 24, 29) it was necessary to group recovery data by 6-minute squares for reasons described previously; in such cases, the nature of the plotting is included in the figure title.

Definition of Lobster Maturity

Subsequent references to maturity stage of individual lobsters assumes that the commonly prevailing minimum legal size (81 mm carapace length) is an acceptable beginning point at which both male and female lobsters attain functional sexual maturity. Skud and Perkins (1969) reported that demonstrable sexual maturity, as evidenced by external embryonated eggs or mature ovarian eggs, commenced at 80 mm carapace length in large samples of female lobsters from the same areas in which we conducted our tagging study. Stewart (1972) examined 1,018 female lobsters from western Long Island Sound and Block Island Sound for presence of spermatophores in the seminal receptacle; the median size of inseminated females in the sample (size range 53 to 106 mm carapace length) was 76 mm, and within the size class 81-82 mm (53 specimens), 81% were inseminated. Krouse (1973) found that male lobsters from the Boothbay region of Maine were virtually all sexually mature well below the legal recruit size of 81 mm; these findings were based on dissection of the genital tracts and microscopic findings of mature sperm cells and spermatophores; Krouse (1973) reiterated the observations of Templeman (1934) that significant size disparity between male and female lobsters precludes succes mating and that prerecruit size males seem unlikel contribute materially to natural reproduction until they attain a size equality with sexually mature females

MIGRATION VERSUS DISPERSION

Cooper and Uzmann (1971) earlier hypothesized the basis of a described time-temperature relationship, that the nature of the migration phenomenon was a vernal shoalward movement to warmer water with su quent return to the edge and slope of the shelf with onset of fall and winter. In subsequent sections of this report we will attempt to elicit qualitative and qu titative aspects of individual movements from group of individuals referenced to release locality, poin of recapture, and time at large.

Hypothetical track lines have been drawn in all c where dispersion or migration (definitions preser below) from point of release to point of recapture exceeded 10 nautical miles (18.5 km) (Figs. 5-29). We must concede at the outset of this discussion that the magnit direction, and time scale of a point-to-point trac seldom an accurate portrayal of the exact movements of any tagged animals; however, the assumption of a straight-line track, however simplistic, is tenable for purposes of plotting, overview, analysis, and ultimat y, for distinction between the short-term probable migrants and the longer-term dispersed individuals. The guid factors in this distinction of kinds, i.e., migrant or persed, are distance traversed and time at large, the elements of the classical ground speed formula D/T.

Ranking of the total array of recovery data by vari combinations shows that the maximum movemen any recapture was 186 nautical miles (345 km) in 71 days (2.6 miles/day). Other sesonable tracks in excess of 100 miles (185 km) were 125 (232 km)/86 days, 123 (228 k 76 days, 118 (219 km)/107 days, 111 (206 km)/108 da, and 102 (189 km)/29 days. Twelve other lobsters made apparently directed tracks of 50-87 miles (93-161 km) within 22-41 days. The calculated ground speeds these 31 examples range from 1 to 5.5 miles (1.8-10.2 k) per day and indicate that directional movements in excess of 1 mile (1.8 km) per day are not uncommon if n in fact, quite normal.

We have developed a classification scheme which attempts to distinguish between directed migrants and those whose net movements over time are inconsequ tial or not clearly directional; the 31 examples ci above provide a logical basis for fixing constraints on the numerical values of time and distance consistent with an acceptable definition of the term "migrant."

The frequency distribution of distance traveled sho that 163 individuals were recovered within 0-9 miles (0-16.8 km) of point of release over the time range 0-950 days. Clearly, there is no internal evidence that any these have dispersed significantly. In the time frequen interval 0-9 days, 15 of 21 recoveries were common to the

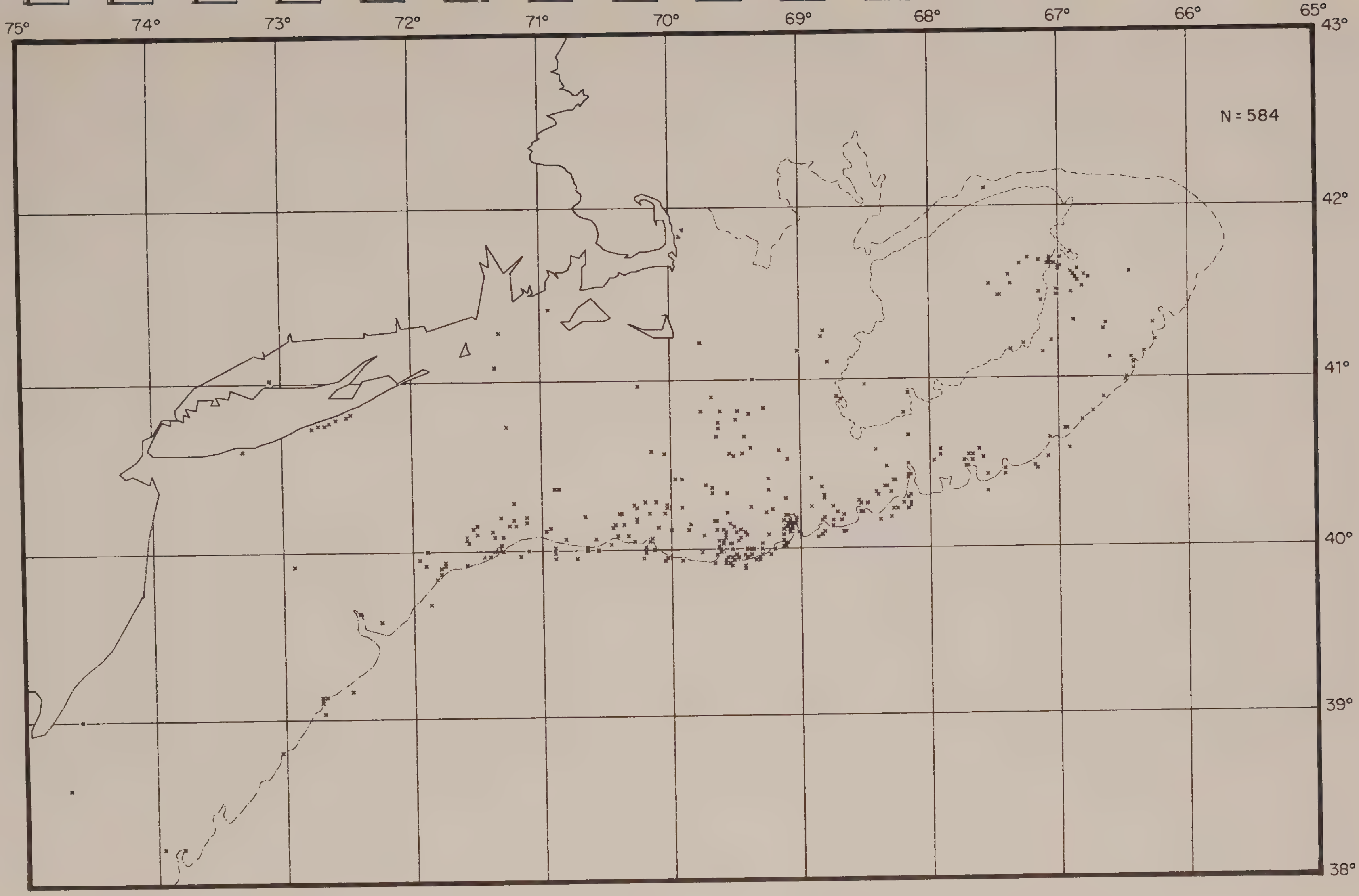
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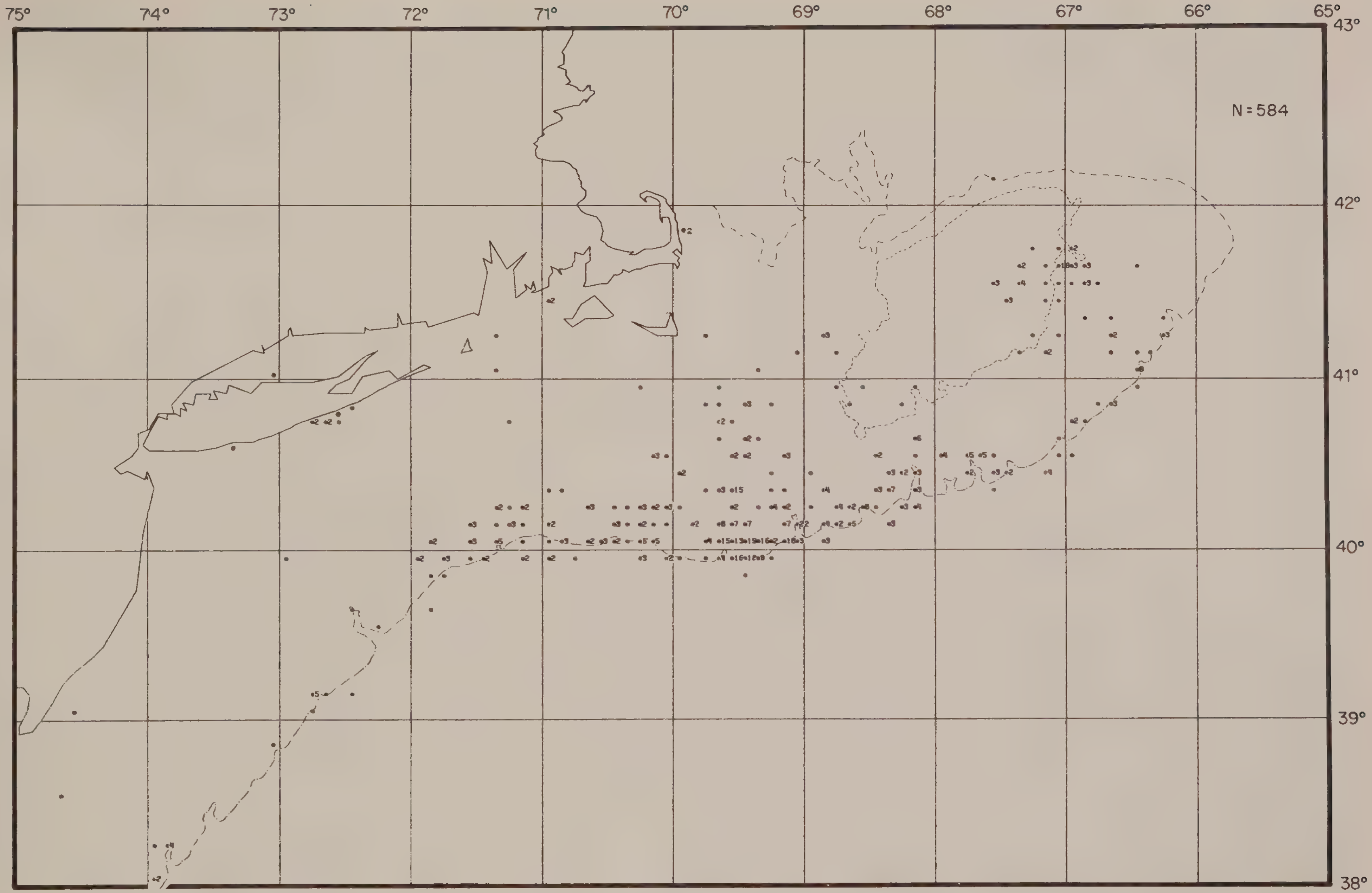
Figure 3.—Composite of tagged lobster recoveries, 1968-72.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N=584

4.—C te of lobst veries ed by te squ 968-7 ementioned 0.9 mile (0.16.8 km) category. Accord- y, we have adopted the premise that time or dis- e values under 10 preclude realistic interpretation of ctionality or speed of movement.

ommercial fishing effort, monthly distribution erns of tagged recoveries (Figs. 34-45), and support- details (appendix tables) all combine to show that hore lobsters are essentially aggregated along the out- dge and slope of the continental shelf during January ugh April (120 days) and become widely dispersed by ration or random movement in shoaler/warmer water ing May through December (245 days). We have set upper limit of duration of a directed migration at 120 s, or the theoretical half-life of a migratory season ing which the migrant can move to shoaler/warmer er and return to the continental shelf margin in ap- imate phase with the annual shoalward and seaward ration of the bottom temperature warm front (here ned as the 10°C isotherm). Within these constraints regarded a total of 117 individuals as migrants; rank- of these individuals by calculated ground speed ws a range of 0.1-5.5 miles (0.18-10.2 km) per day, a dian speed of 0.9 miles (1.7 km) per day, and a median .6 miles (1.1 km) per day. Ground speeds of defined rants are positively correlated with distance travers- and negatively correlated with time at large.

he remainder of recaptures for which capture loca- and time at large are known fall into three categories elative displacement from point of release. Our work- definitions of migrant and alternative classifications as follows:

) Migrant by virtue of track ≥ 10 nautical miles (18.5) and time at large 10-120 days (N = 117).

) Nonmigrant by corollary definition of track <10 es and time at large <10 days (N = 15).

) Residual nonmigrant by virtue of track <10 miles, e at large ≥ 10 days (range 15-950); this classification ects stationary behavior, or the alternative possibility ndetectable excursion(s) with homing back to release ality (i.e., within 10-mile radius of release point) (N .47).

) Indeterminate by virtue of track ≥ 10 miles (range 181), time at large >120 days (range 125-1,549); move- nt is regarded as random dispersal, a summation of ration tracks, or a combination of both (N = 297).

ht recaptures were reported without dates of recap- e and hence could not be classified. These alternative ssifications make for interesting conjecture in many es; among the indeterminates, for example, we find ny probable examples of directed migration which not be properly assessed because of the associated nent of excessive time at large; these cases will be ntified and discussed under the appropriate com- ite station résumés which follow this section.

eturning to the reliability of ground speed calculated m D/T, we have assumed that D is probably underestimated in most cases because a lobster track of significant distance over the bottom is unlikely to be straight-line, and also because some of the recaptures were likely on a return course relative to their original shoalward vector. Conversely, T is probably overestimated (but never underestimated) in a majority of cases because the migrant under consideration had 1) earlier arrived at destination, 2) had accumulative rest periods, and/or 3) was on a return vector. The net effect of any or all of these possible biases on calculated ground speed is to underestimate the derivation in general and to give added credence to values on the order of 4-5 miles (7.4-9.3 km) per day.

COMPOSITE STATION RÉSUMÉS

Composite Station 1 (See Appendix Table 1)

Three recaptures have been reported from a composite total of 42 releases in the vicinity of Oceanographer Canyon on 15 March 1968 (28), 16 March 1968 (5), and 30 March 1968 (9). Mean depth at first capture was 153 fathoms (280 m); mean depth at release was 175 fathoms (320 m). Only one of the recoveries was reported by location. The sex ratio of the three returns was one female to two males.

The most noteworthy feature of the recoveries from this composite release is the relatively high mean time at large (985 days =2.7 yr) which exceeds that of all other subgroups of recoveries. The single located recovery, a mature male, was captured 13 miles (24.1 km) from its original release point and had been at large 1,342 days (3.7 yr).

Here, as in many other cases of lengthy time at large, the relatively small displacement from original release locality is indicative of either highly localized movements over time or, alternatively, a homing tendency following larger scale movements. We prefer the latter hypothesis and will attempt to sustain this view in the remainder of the text on the basis of other individual and collective returns.

Composite Station 2 (See Figure 5 and Appendix Table 2)

Three recaptures, all males, have been reported from a single point release of 13 lobsters near the head of Veatch Canyon on 4 April 1968. First capture depth and release depth were at 110 fathoms (201 m). Two of the recaptures were reported by location with neither having migrated very far nor having been at large very long. The third recapture, a mature male, had been at large 741 days (2.0 yr), and was reported taken in the vicinity of Veatch Canyon without specific coordinates.

This subgroup of recoveries represents the highest rate of recapture (23%) among the 29 subgroups of releases and indicates that numerically small releases of tagged lobsters can yield significant returns.

Composite Station 3 (See Figure 6 and Appendix Table 3)

Nine recaptures have been reported from a single point release of 146 lobsters on the east side of Hudson Canyon on 26 April 1968. First capture depth was 160 fathoms (293 m); release depth was 85 fathoms (155 m). Seven of the nine recaptures were reported by location and one other from the vicinity of Hudson Canyon. Sex ratio of the nine recaptures was seven females to two males. Mean time at large was 252 days (0.7 yr). Two of the recaptures (3F, 29F) from this release, both mature females, are classified as migrants and were captured 29 and 118 days later in coastal trap fisheries off Long Island, N.Y., after having migrated 102 miles (189 km) and 77 miles (143 km), respectively. The longest outstanding recapture (660 F), an immature female at release, was at large 1,024 days (2.8 yr) during which time it increased 32% in carapace length, which is indicative of at least two moult increments (Cooper and Uzmann 1971).

Three of the recoveries (3F, 29F, 4F) were migrants within the terms prescribed in the preceding section. Return 3F was recaptured 29 days after release following a 102-mile (189-km) migration to shoal water, at 3.5 miles (6.5 km) per day. Return 29F, on the other hand, showed a net displacement of 77 miles (143 km) over the much longer period of 118 days; the calculated speed of 0.6 miles (1.1 km) per day is well below the mean speed of the collective 117 defined migrants and inconsistent with an idealized ongoing shoalward track. In the absence of any contradictory evidence, it seems logical to conclude that this individual and others, as will be seen, probably arrived in the vicinity of their recapture at considerably earlier dates. Return 11F was recaptured 13 miles (24.1 km) northwesterly in slightly deeper water than at release.

Composite Station 4 (See Figure 7 and Appendix Table 4)

Seven recaptures have been reported from a single point release of 52 lobsters several miles east of Block Canyon on 28 April 1968. First capture depth was 190 fathoms (347 m); release depth was 100 fathoms (183 m). Four of the seven recaptures were reported by location. Sex ratio of the seven recaptures was three females to four males. Mean time at large was 425 days (1.2 yr). One of the four located recaptures, a mature male, moved 71 miles (132 km) easterly over a period of 405 days at large. The longest outstanding recapture (location unreported) in this subgroup was at large 1,326 days (3.6 yr).

Composite Station 5 (See Figure 8 and Appendix Table 5)

Twenty-nine recaptures have been reported from a composite total of 264 releases west of Atlantis Canyon on 29 March 1968 (142) and 30 March 1968 (122). Mean depth at first capture was 190 fathoms (347 m); mean depth at release was 99 fathoms (181 m). Twenty of the recaptures were reported by specific location and one by approximate location.

Sex ratio of the returns was 22 females to 7 males, n significantly different from the ratio at release (212 females to 52 males).

Mean time at large for all recoveries was 284 days (0 yr); greatest time at large for a located individual w 774 days (2.1 yr) during which time apparent dispersion was only 10 miles (18.5 km).

Mean distance traveled by those lobsters with speci recapture locations (20) was 25.1 miles. Three individuals, all sexually mature females, made migrations in excess of 50 miles (92.7 km), the range being 56- miles (104-141 km).

Four of the recoveries (28F, 26F, 27F, 4F), all mature females, are classified migrants; all were recaptured in June within 36-50 days after tagging. Return 28F, an eg bearing female at release and recapture, was taken miles (104 km) northeasterly in significantly shoaler water (22 fathoms = 40.2 m) after 50 days at large; apparent speed (1.1 miles/day = 2.0 km/day) and directi are highly consistent with the vernal shoaling hypothesi

Returns 26F and 27F (egg-bearing at release and recapture) were taken 38 miles (70.4 km) easterly ne the head of Veatch Canyon at 80 fathoms (148 m) aft being at large 36 and 37 days, respectively; apparent speed in each case was 1.1 miles/day (2.0 km/day). It is obvious that these tracks are not consistent with theoretical goal of shoaler location; we will reserve con ment on these and others of similar nature for later discussion. Return 4F was taken 11 miles northeasterly in significantly shoaler (64 fathoms = 117 m) water; th recovery illustrates quite well that lobsters occupying t shelf edge or slope can achieve much shoaler (or deeper) locations with relatively small excursions.

Composite Station 6 (See Figure 9 and Appendix Table 6)

Twenty-two recaptures have been reported from composite total of 149 releases midway between Atlantis and Veatch canyons on 1 May 1968 (78) and 2 May 1968 (71). Mean depth at first capture was 190 fathoms (34 m); mean depth at release was 99 fathoms (181 m). Nineteen of the recoveries were reported by specific location and one by approximate location. Sex ratio at release was 103 females (69%) to 46 males; the ratio at recapture wa 12 females (55%) to 10 males.

Mean time at large for all recoveries was 312 days (0.9 yr); greatest time at large for a located individual, an im mature male at release, was 896 days (2.4 yr) durin which time apparent dispersion was only 18 miles (33. km).

Mean distance traveled by those lobsters with specifi capture locations (19) was 33.5 miles (62.1 km). Five individuals made migrations in excess of 50 miles (92.7 km), the range being 57-71 miles (106-132 km). Three of these long distance migrants were mature females, one which (91F) was berried at recapture; the remaining tw were mature males.

Six of these recaptures (9F, 10F, 1M, 18F, 19F, 20M) be classified as migrants. Recoveries 9F and 10F ed easterly, with the latter being taken significantly aler (56 fathoms = 102 m) than at release. Return 1M rated at near record speed of 5.1 miles (9.4 km) per to a point 62 miles (115 km) westerly at a depth (120 oms = 219 m) significantly deeper than at release. e release depth here, as at a number of other stations, significantly shoaler than release depth for reasons ained earlier; it is conceivable, therefore, that bot- temperature at the release site was sufficiently ergent to cause abnormal behavior. Returns 18F, 19F, 20M were recaptured at the same point in time and e after 49 days at large; their recovery position was miles (33.4 km) easterly in shoaler (69 fathoms = 126 water.

posite Station 7 (See Figure 10 and pendix Table 7)

n recaptures have been reported from a single point ase of 99 lobsters on the west side of Veatch Canyon 2 May 1968. Mean depth at first capture was 200 oms (366 m); mean depth at release was 100 fathoms m). Eight of the recaptures were reported by specific ation. Sex ratio at release was 77 females (77%) to 22 les; the ratio of the returns was 7 females (70%) to 3 s.

ean time at large for all recoveries was 477 days (1.3 ; greatest time at large for a located individual, a ture female, was 771 days (2.1 yr). This individual recaptured 58 miles (107 km) north of the point of ase in June 1970; its location in time and space is consent with a working hypothesis of seasonal shoaling return to home locality.

ean distance traveled by those lobsters with specific ture locations (8) was 29.3 miles (54.4 km). Two iniduals qualified as long migrants; one of these was the ure female noted above while the other was a mature e.

mong the eight located recaptures, only one (8M) is a ined migrant and is consistent with the springtime aling hypothesis; this individual ranged shoalward n 100 to 63 fathoms (183-115 m) at a net speed of 1.8 les (3.3 km) per day.

nposite Station 8 (See Figure 11 and pendix Table 8)

our recaptures have been reported from a single point ase of 50 lobsters on the east side of Atlantis Canyon 14 June 1968. Mean depth at first capture was 70 oms (128 m); mean depth at release was 86 fathoms m). Two of the recoveries were reported by specific tion and one by approximate location. Sex ratio at ase was 30 females (60%) to 20 males; the ratio at pture was 1 female to 3 males.

ean time at large for all recoveries was 386 days (1.1 ; greatest time at large for a located individual, a mature male, was 734 days (2.0 yr), during which time apparent dispersion was 26 miles (48.2 km).

Maximum dispersion was attained by 156M, a mature male, which was recaptured 114 miles (211 km) easterly near the head of Lydonia Canyon. A third individual, a mature female, was reported from the vicinity of Hudson Canyon, some 100 miles (185 km) westerly of release.

Composite Station 9 (See Figure 12 and Appendix Table 9)

Nineteen recaptures have been reported from a single point release of 143 lobsters on the west side of Atlantis Canyon on 15 June 1968. Mean depth at first capture was 70 fathoms (128 m); mean depth at release was 100 fathoms (183 m). Thirteen of the recaptures were reported by specific location and two by approximate location. Sex ratio at release was 72 females (50%) to 71 males; the ratio at recapture was 11 females (58%) to 8 males.

Mean time at large for all recoveries was 623 days (1.7 yr); greatest time at large, and record high overall, for a located individual (946M), a mature male at release, was 1,549 days (4.2 yr). This individual was recaptured 118 miles (219 km) easterly at Lydonia Canyon and had increased 63% in carapace length by virtue of at least three molts.

Mean distance traveled by those lobsters with specific capture locations (13) was 36.1 miles (66.9 km). Three individuals, a mature female, an initially immature male, and the mature male cited above, surpassed the 50-mile (92.7-km) range from point of release.

Composite Station 10 (See Appendix Table 10)

Three recaptures have been reported from a single point release of 39 lobsters some 15 miles (27.8 km) northeasterly of Atlantis Canyon on 16 June 1968. Mean depth at first capture was 90 fathoms (165 m); mean depth at release was 60 fathoms (110 m). All recaptures were reported by specific location. Sex ratio at release was 25 females (64%) to 14 males; the ratio at recapture was 2 females to 1 male, all being sexually immature.

Mean time at large (48 days) and mean distance traveled (14 miles = 25.9 km) were lowest and second lowest, respectively, among all subgroups of returns. The low rate of return, and particularly the disappearance of the group after only 60 days at large, suggests that unusually high mortality occurred shortly after release.

Two of the three recoveries (34F, 41F) are migrants by definition; both were immature females and were taken only slightly shoaler than release depth. The directionality of these tracks, as with many others among the defined migrants, has not resulted in maximum shoaling for distance traversed; it seems plausible, however, that those individuals, especially immatures, captured and released well up on the shelf as late as June might, in the main, have already completed a migratory transition from colder slope water to the seasonably warmer shelf water prior to recapture. An extension of this reasoning suggests further that others captured and tagged at these midshelf depths were still en route to shoaler grounds (e.g., recapture 25F discussed under subsequent account of composite station 13).

Composite Station 11 (See Figure 13 and Appendix Table 11)

Six recaptures have been reported from a single point release of 84 lobsters 7 miles (12.9 km) north of Atlantis Canyon on 16 June 1968. Mean depth at first capture was 60 fathoms (110 m); mean depth at release was 55 fathoms (101 m). All of the recaptures were reported by specific location. Sex ratio at release was 47 females (56%) to 37 males; the ratio at recapture was 5 females (83%) to 1 male.

Mean time at large for all recoveries was 361 days (1.0 yr). Greatest time at large was 727 days (2.0 yr); the individual involved was an immature female at release and one of two females in the subgroup of returns which surpassed the 50-mile (92.7-km) range of dispersion from release point. Mean distance traveled by the six recoveries was 32.2 miles (59.7 km).

Composite Station 12 (See Figure 14 and Appendix Table 12)

Three recoveries have been reported from a single point release of 57 lobsters 10 miles (18.5 km) northeast of Block Canyon on 16 June 1968. Mean depth at first capture and at release was 60 fathoms (110 m). All three recaptures were reported by specific location. Sex ratio at release was 25 females (44%) to 32 males; the ratio at recapture was 1 female to 2 males.

Mean time at large for all recoveries was 231 days (0.6 yr); greatest time at large was 358 days (1.0 yr) during which time the record individual, a mature male at release, traveled 52 miles (96.4 km) east to the east side of Veatch Canyon. Mean distance traveled by the three recoveries was 30.3 miles (56.2 km).

Composite Station 13 (See Figure 15 and Appendix Table 13)

Forty recaptures have been reported from a composite total of 482 releases west of Block Canyon on 18 and 19 June 1968. Mean depth at first capture was 60 fathoms (110 m); mean depth at release was 47 fathoms (86 m). Twenty-three of the recaptures were reported by specific location and three by approximate location. Sex ratio at release was 256 females (53%) to 226 males; the ratio at recapture was 25 females (62%) to 15 males.

Mean time at large for all accountable (37) recoveries was 484 days (1.3 yr); greatest time at large for a located individual, a mature female at release, was 1,360 days (3.7 yr). This individual was recaptured 72 miles (133 km) southwest from point of release.

Mean distance traveled by those lobsters with specific capture locations was 52.1 miles (96.6 km), the rec high average for all subgroups of returns. Twelve dividuals surpassed the 50-mile (92.7-km) range; additionally, three others were reported from the vicinity of Veatch Canyon which is well beyond the 50-mile (92 km) range from point of release. A disproportiona number (12/15) of the long-distance migrants were females; most of the females were sexually mature release and all were sexually mature at recapture.

Two females were recaptured in the coastal trap fishery off southern Long Island, N.Y. One of these (25F) was berried at release and at recapture after havi migrated 75 miles (139 km) in 28 days (2.7 miles/day 5.0 km/day). The short term and long distance of this movement clearly supports an hypothesis of directed migration to warmer waters. The second female (335 taken in the coastal zone was at large 465 days (1.3 and, judging from its size at release, conceivably was engaged in a second or even third seasonal inshore migr tion.

Three recoveries (25F, 22F, 42M) are classified migrants. Return 25F, noted above, was recaptured in a local trap fishery at Fire Island Inlet, N.Y., in 7 fatho (12.8 m) of water; vector and ground speed well e emplify the vernal shoaling concept. Return 22F was taken 14 days after release at a point 23 miles (42.6 km) southeasterly in slightly deeper water (60 fathoms = 1 m) than depth at release (47 fathoms = 86.0 m); it significant, perhaps, that recapture depth and original capture depth were identical. We do not imply that this individual sought to return to original depth, but given depth/temperature constant relationship over sho term, it is conceivable that this lobster sought to return to its original temperature stratum. Return 42M, an i mature male, was recaptured 58 days later and 47 mi (87.1 km) northeasterly in 50 fathoms (91.4 m) of water, considering immaturity and time of year, the net track would seem biologically unproductive.

Composite Station 14 (See Figure 16 and Appendix Table 14)

Twenty-five recaptures have been reported from a composite total of 266 releases 15 miles (27.8 km) northwest of Block Canyon on 20 June 1968. Mean dep at first capture was 60 fathoms (110 m); mean depth release was 49 fathoms (89.6 m). Twenty-two of the recoveries were reported by specific location and one b approximate location. Sex ratio at release was 1 females (55%) to 120 males; ratio at recapture was 1 females (76%) to 6 males.

Mean time at large for all accountable (24) recoveri was 401 days (1.1 yr); greatest time at large for a locate individual, a mature female at release, was 1,077 days (2.9 yr). This lobster (726F) was recaptured 181 miles (335 km) easterly near the head of Oceanographer Ca yon; the hypothetical straight-line track is the penult mate distance record and is exceeded slightly by that of mature female (249F) recaptured just off the north e of Long Island, N.Y. (see Fig. 20).

ean distance traveled by those lobsters with specific pture locations was 46.9 miles (86.9 km). Eleven in- iduals, fully half of the located returns, surpassed the ile (92.7-km) range with a disproportionate number eing females. Four of the eleven, all females, were en by a single fisherman in the seasonal trap fishery southern Long Island; unfortunately, only the tag r code and sex were reported and we are unable to late beyond date and original release station.

Among the 22 located recaptures, only one (33M) is a ned migrant; this individual moved southwesterly e 12 miles (22.2 km) and was recaptured at the same h as at release.

Return 269M, and the four females mentioned above F, 348F, 349F, 350F) were taken approximately 1 yr release in the southern Long Island trap fishery in 12 fathoms (20.1-21.9 m) of water; while not migrants the strictly defined sense, these recaptures are special s which probably represent directed migrations of year (1969) in which captured.

mposite Station 15 (See Figure 17 and pendix Table 15)

Ten recaptures have been reported from a single point ase of 46 lobsters on the so-called Leg area of Georges k on 21 September 1968. Mean depth at first capture 35 fathoms (64.0 m); release depth was 28 fathoms .2 m). Six of the recaptures were reported by specific tion. Sex ratio at release was 23 females (50%) to 23 es; the ratio at recapture was 6 females (60%) to 4 les.

Mean time at large for all recoveries was 434 days (1.2 greatest time at large for a located individual, a ure female at release, was 759 days (2.1 yr); this ster apparently traveled only 12 miles (22.2 km), but is evident from monthly distribution patterns eloped later in this report that lobsters would not re- n localized in this general area; time at large closely proximates an anniversary of the initial tagging event this area and supports an hypothesis of seasonal sitation to shoaler, warmer water.

Mean distance traveled by those lobsters with specific pture locations was only 16 miles (29.7 km); reference Appendix Table 15 shows that five of the six account- e recoveries were taken 1 or 2 calendar years later ring the warmest half of the year either at the shelf ge (548F), or relatively near the release area. The sixth F), taken in November, 44 days after release, was con- ably engaged in retreat from oncoming winter con- ions to the warmer sanctuary of the shelf edge and pe. The high percentage (21.7) of recaptured lobsters n this release is second only to the slightly higher rate ecapture from Composite Station 2.

mposite Station 16 (See Figure 18 and pendix Table 16)

Fifty-nine recaptures have been reported from a composite total of 479 releases near the southwest corner of Georges Bank on 24, 25, and 26 September 1968. Mean depth at first capture was 50 fathoms (91.4 m); mean depth at release was 40 fathoms (73.2 m). Thirty-nine of the recaptures were reported by specific location and eight by approximate location. Sex ratio at release was 196 females (41%) to 283 males; the ratio at return was 20 females (34%) to 39 males.

Mean time at large for all accountable (58) recoveries was 435 days (1.2 yr); greatest time at large for a located individual (932M), a mature male at release, was 1,407 days (3.8 yr).

Mean distance traveled by those lobsters with specific capture locations (39) was 34.8 miles (64.5 km). Nine individuals, the majority being mature, surpassed the 50-mile (92.7-km) range. Additionally, four others, two males and two females, were reported from the Veatch Canyon area, some 50 miles (92.7 km) from point of release. Maximum dispersion (107 miles = 198 km) from release point was achieved by an immature male (362M) while at large 411 days (1.1 yr).

Six of the 59 recaptures were migrants. Two of these (45F, 46M) were recaptured in October in slightly shoaler water; three (52F, 55F, 54M) were taken in November in slightly deeper (50 fathoms = 91.4 m) water, and one (75M) was taken the following January at a depth of 155 fathoms (284 m). Considering the respective dates of recapture, the tracks show a net tendency toward return to deeper water with the onset of winter season.

Composite Station 17 (See Figure 19 and Appendix Table 17)

Twenty-seven recaptures have been reported from a composite total of 223 releases near the head of Lydonia Canyon on 15 and 16 October 1968. Mean depth at first capture was 45 fathoms (82.3 m); mean depth at release was 71 fathoms (130 m). Fourteen lobsters were reported by specific location and seven by approximate location. Sex ratio at release was 138 females (62%) to 85 males; the ratio at return was 14 females (52%) to 13 males.

Mean time at large for all accountable (20) recoveries was 652 days (1.8 yr); greatest time at large for a located individual, a mature male at release, was 1,372 days (3.8 yr).

Mean distance traveled by those individuals with specific capture locations (14) was 37.4 miles (69.3 km); four individuals, three mature females and one mature male, surpassed the 50-mile (92.7-km) range as did six others which were reported from approximated canyon localities. Among this latter group, five of the six were larger, sexually mature individuals at release, thus confirming the apparent tendency of larger lobsters to migrate or disperse more so than smaller individuals. Maximum dispersion (132 miles = 245 km) was achieved by a mature male (937M) which had been at large 973 days (2.7 yr); this individual was recaptured in a coastal trap fishery on outer Cape Cod.

The single migrant of this group, a mature male (56M), moved easterly some 29 miles (53.7 km) over a period of

39 days and was recaptured at a depth of 100 fathoms (183 m); track direction and timing is consistent with hypothesized overwintering at and below the continental shelf margin. Return 357F, recaptured in October of the following year, is regarded as a migrant of the year 1969.

Composite Station 18 (See Figure 20 and Appendix Table 18)

Two hundred thirteen recaptures have been reported from a composite total of 1,350 releases some 7 miles (13.0 km) easterly of the head of Veatch Canyon on 30 April and 1 and 2 May 1969. Mean depth at first capture was 137 fathoms (251 m); mean depth at release was 71 fathoms (130 m). These subgroups, like several others, were released shoaler than capture depth to avoid the likelihood of immediate recapture by our own vessel or other commercial vessels trawling in the vicinity of initial capture. One hundred eleven of the recaptures were reported by specific location and 36 by approximate location. In Figure 20 the recoveries are grouped and plotted by 6-minute squares for reasons given earlier. Sex ratio at release was 582 females (43%) to 768 males. The ratio at return was 97 females (46%) to 116 males.

Mean time at large for all accountable (208) recoveries was 275 days (0.7 yr). Maximum time at large for a located individual (863F), a mature female at release, was 950 days (2.6 yr), during which time net displacement from release locality was only 7 miles (13.0 km).

Mean dispersion of the 111 recaptures with specific capture locations was 25.3 miles (46.9 km). Ten females and six males, the majority being mature at release, surpassed the 50-mile (92.7-km) range; among these 16, four (249F, 477F, 359M, 720M) ranged well beyond 100 miles (204 km).

Fifteen of the recoveries are defined migrants. The foremost example among these was 249F, a 90-mm female at release; this individual traveled a record 186 miles (345 km) in 71 days (2.6 miles/day = 4.8 km/day) and was recaptured in July in a trap fishery at 7 fathoms (12.8 m) depth on the north shore of Long Island. This extensive penetration into Long Island Sound might be interpreted as an initially directed shoalward vector toward Block Island Sound with unintended overrun into eastern Long Island Sound; thereafter, a southwesterly track would conceivably lead to the vicinity of recapture on the north shore of Long Island. Alternatively, once having entered the constricted eastern end of Long Island Sound, any near-southerly track would result in shoaling on the extensive north shore of Long Island and present the dilemma of choosing correctly between an easterly or westerly course for ultimate return to the open ocean. A westerly track alongshore would also, in this conjectural situation, effectively lead 249F to the point of recapture. This unforeseen situation raises the possibility that other lobsters of offshore origin may follow similar pathways and become entrapped in Long Island Sound by virtue of its confining geography.

The defined migrants within this group are listed below along with track bearing, ground speed, and depth change, and the positive values of depth change signify shoalward movement:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
249F	302°	2.6	4.8	+68	[illegible]
263F	348°	0.9	1.7	+50	+91
240F	036°	2.1	3.9	+36	+66
254F	069°	0.6	1.1	+42	[illegible]
271F	278°	0.3	0.6	−20	[illegible]
283F	073°	0.2	0.4	−20	[illegible]
166F	060°	0.6	1.1	0	0
158F	058°	0.5	0.9	−5	−9
221F	081°	0.2	0.4	+10	[illegible]
201M	072°	0.8	1.5	0	[illegible]
311M	006°	0.4	0.7	+45	[illegible]
199M	067°	0.7	1.3	+5	+9
266M	296°	0.2	0.4	+15	[illegible]
160M	066°	0.6	1.1	−12	[illegible]
300M	072°	0.2	0.4	−20	[illegible]

The initial bearing of 249F is measured to a point east of Montauk Point consistent with assumed straight- penetration of eastern Long Island Sound; the su quent track or tracks to point of recapture are highly conjectural as discussed above. Eight of the fifteen migr moved shoalward, two remained at release depth, five moved to deeper water. Among the five returning to deeper water, three were immature females.

Composite Station 19 (See Figure 21 and Appendix Table 19)

One hundred four recaptures have been reported f a single point release of 751 lobsters some 12 miles (km) southwesterly of Hydrographer Canyon on 4 May 1969. Depth at first capture was 150 fathoms (274 depth at release was 65 fathoms (119 m). Sixty- recaptures were reported by specific location and 24 approximate location. Sex ratio at release was 362 females (48%) to 389 males; the ratio at return was females (55%) to 47 males.

Mean time at large for all accountable (96) recoveries was 286 days (0.8 yr); greatest time at large for a located individual (673F), a mature female at release, was days (2.0 yr).

Mean distance traveled by individuals with specific capture locations (61) was 26.7 miles (49.5 km); seven individuals (294F, 610F, 246M, 317M, 480M, 570M, 577 exceeded the 50-mile (92.7-km) range from release po Six of these seven long-ranging individuals were sexually mature at release; the seventh (480M) was mature recapture some 10 mo from release.

Maximum dispersion (125 miles = 232 km) was achieved by a mature male (317M) which moved northeasterly onto Georges Shoals at an apparent grou speed of 1.4 miles (2.6 km) per day. Two others (29 570M) also exceeded the 100-mile (185-km) range; these three cases of wide dispersion from release point are good examples of the contrasting distinction between defi migrants (317M and 294F) and the defined inde minate (570M): the former show ground speeds in excess mile (1.85 km) per day along hypothetical track lines are probably realistic approximations of actual s made good; the latter (570M) was recaptured 14 after release and shows a net displacement of 115 s (213 km). In this situation, the track is simply a ht-line resolution of some unknown number of ments over long term which have resulted in a ma- vesterly displacement; the timing and directionality ne component steps cannot be deduced or inferred the available information.

e defined migrants (13) within this group are listed w with ground speed and depth change:

rn no.	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
5F	0.6	1.1	+45	+82
F	1.1	2.0	+47	+86
F	1.1	2.0	+32	+59
oF	0.4	0.7	0	0
2F	0.4	0.7	−7	−13
4F	0.4	0.7	+10	+18
F	0.3	0.6	+15	+27
F	0.1	0.2	−25	−46
6M	0.8	1.5	+48	+88
0M	0.5	0.9	−25	−46
M	1.4	2.6	+38	+70
M	0.3	0.6	+15	+27
M	0.4	0.7	+10	+18

posite Station 20 (See Figure 22 and endix Table 20)

ty-four recaptures have been reported from a posite total of 387 releases made 25 miles (46.3 km) hwest of Corsair Canyon over the 3-day period, 7, 8, May 1969. Mean depth at first capture was 173 ms (316 m) with range 160-180 fathoms (293-329 depth at release for all releases was 50 fathoms (91.4 Thirty-seven recaptures were reported by specific on and one by approximate location. Sex ratio at se was 274 (71%) females to 113 males; the ratio at rn was 29 (66%) females to 15 males.

an time at large for accountable (44) recoveries was ays (0.5 yr); greatest time at large for a located in- dual (897M), a mature male at release, was 1,075 (2.9 yr) with recapture 27 miles (50.0 km) from e point.

an distance traveled by individuals with specific ure locations (37) was 30.4 miles (56.3 km); four in- duals (306F, 315F, 578F, 697F), all sexually mature es, equalled or exceeded the 50-mile (92.7-km) from point of release. Maximum dispersion (143 s = 265 km) was attained by 697F which was recap- near Veatch Canyon 761 days (2.1 yr) following e. This group of recoveries includes the second st number (21) and percentage (56) of definable ants, 21 of 37. Collectively, the migrants are cterized by relatively large size, a high proportion of females, and, among the females, a high propor- (44%) with external eggs at release.

The defined migrants (21) within this group are listed below with track bearing, ground speed, and depth change:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
148F	056°	1.0	1.9	−85	−155
161F	227°	0.8	1.5	−40	−73
244F	329°	0.5	0.9	+16	+29
252F	329°	0.5	0.9	+16	+29
259F	327°	0.7	1.3	+23	+42
276F	337°	0.5	0.9	+18	+33
277F	337°	0.5	0.9	+18	+33
306F	323°	0.5	0.9	+22	+40
314F	314°	0.6	1.1	+23	+42
315F	315°	0.6	1.1	+23	+42
171F	036°	0.3	0.6	−45	−82
198F	222°	0.4	0.7	−35	−64
209F	079°	0.2	0.4	−42	−77
228F	225°	0.2	0.4	−30	−55
239F	079°	0.2	0.4	−32	−59
247F	009°	0.3	0.6	+11	+20
149M	056°	1.0	1.9	−85	−155
150M	043°	1.0	1.9	−85	−155
200M	334°	0.8	1.5	+13	−24
285M	325°	0.5	0.9	+20	−37
210M	079°	0.2	0.4	−32	−59

It will be noted from the preceding table and Figure 22 that 10 of the 11 migrants showing shoalward displacement were recovered within a 33° arc relative to release point; the significance of this tight grouping is evident only when the recovery positions are plotted on a detailed bathymetric chart of the area encompassed from which it can be seen that the recapture locations are coincident with several areas that are heavily fished in summer months by trawlers fishing primarily for yellowtail flounders. The rugged topography of Georges Bank shoalward of 30 fathoms (54.9 m), coupled with strong tidal currents, greatly limits trawler activity and hence the incidental catch of shoaling lobsters to those areas that are topographically compatible with otter trawl fishing. The relatively large number of tagged lobsters recaptured on this shoaler part of Georges Bank (see also Fig. 24 and related discussion) indicates that this upper reach of the Bank as a whole supports a major summertime concentration of lobsters originating from the continental margin and slope from Veatch Canyon eastward.

Composite Station 21 (See Figure 23 and and Appendix Table 21)

Twenty-three recaptures have been reported from a single point release of 166 lobsters near the head of Lydonia Canyon on 6 June 1969. Depth at first capture was 70 fathoms (128 m); depth at release was 57 fathoms (104 m). Fifteen recaptures were reported by specific locations and six by approximate location. Sex ratio at release was 82 females (49%) to 84 males; the ratio at return was 7 females (30%) to 16 males.

Mean time at large for all accountable (19) recoveries was 264 days (0.7 yr); greatest time at large for a located individual (851M), a mature male at release, was 885 days (2.4 yr).

Mean distance traveled by individuals with specific capture locations (15) was 30.1 miles (55.8 km); four individuals (186F, 262F, 399F, 352M), all sexually mature at release, exceeded the 50-mile (92.7-km) range from release point.

Maximum dispersion was attained by 399F which moved a net distance of 82 miles (152 km) easterly over a period of 167 days (0.4 yr).

The defined migrants (4) within this group of recaptures are listed below with track bearing, ground speed, and depth change:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
262F	032°	1.7	3.2	+24	+44
352M	304°	0.6	1.1	+2	+4
230M	117°	0.5	0.9	−23	−42
231M	117°	0.5	0.9	−23	−42

Return 262F (44 days at large) approaches the idealized view of seasonal shoalward migration, but 352M, 230M, and 231M do not. In view of their relatively short term at large (22 days) it is possible that these last three had simply reoriented toward the depth-temperature stratum prevailing at first capture.

Recoveries 185F, 186F, and 399F fall outside the migrant classification, but represent significant dispersions with respect to time at large or distance. Both 185F and 186F were at large less than 10 days, but made seemingly directed tracks (without depth change) of 40 miles (74.1 km) and 52 miles (96.4 km), respectively, at calculated ground speeds in excess of 5 miles (9.3 km) per day. Return 399F (167 days at large) was captured at a point 82 miles (152 km) westerly and 17 fathoms (31.1 m) shoaler than point of release; this dispersion is open to interpretation, but may represent the outbound limit of a shoalward migration or simply a point on an inbound return from an even shoaler location.

Composite Station 22 (See Figure 24 and Appendix Table 22)

Forty-six recaptures have been reported from a composite total of 422 releases some 20 miles (37.1 km) southwest of the head of Corsair Canyon on 10 and 11 June 1969. Mean depth at first capture was 87 fathoms (159 m); mean depth at release was 51 fathoms (93.3 m). Thirty-nine lobsters were reported by specific location and one by approximate location. Sex ratio at release was 280 females (66%) to 142 males; the ratio at return was 28 females (61%) to 18 males.

Mean time at large for all accountable (43) recoveries was 157 days (0.4 yr); greatest time at large for a located individual (898M), a mature male at release, was 1,034 days (2.8 yr) with recapture 11 miles (20.4 km) from release point. This individual showed a 39% increase in carapace length at recapture which suggests that at least two molts occurred during its time at large.

Mean distance traveled by individuals with specifi capture locations (39) was 44 miles (81.5 km); fiv [illegible] dividuals (237F, 575F, 770F, 303M, 747M) surpassed [illegible] 50-mile (92.7-km) range from point of release by a considerable margin (range 87-164 miles = 161-304 km). Maximum movement was attained by 747M (see Fig [illegible] which was recaptured 865 days (2.4 yr) following rele[illegible]e runner-up in this category was 575F, a large egg-bearing female at release, which was taken in a coastal [illegible] fishery at Truro Beach, Mass., 431 days (1.2 yr) follow [illegible] release.

This group of recoveries includes the largest number (28) and percentage (71) of definable migrants with 2[illegible] 39 located recoveries meeting the "migrant" crit[illegible] defined previously. The migrants here, as at station 20 are characterized by large mean size, a high proportion (61%) of females, and, among the females, a high pro[illegible]tion (59%) with external eggs at release.

Bearing, ground speed, and depth change are given below:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
236F	316°	1.7	3.2	+17	[illegible]
237F	240°	4.4	8.2	−8	[illegible]
238F	337°	1.5	2.8	+18	+33
251F	338°	1.0	1.9	+18	+33
260F	331°	1.0	1.9	+25	[illegible]
284F	322°	0.5	0.9	+17	[illegible]
287F	328°	0.6	1.1	+21	+38
288F	332°	0.6	1.1	+22	+40
293F	329°	0.6	1.1	+14	[illegible]
307F	302°	0.7	1.3	+22	[illegible]
308F	302°	0.7	1.3	+22	[illegible]
309F	302°	0.7	1.3	+22	+40
316F	307°	0.9	1.7	+25	+46
336F	300°	0.5	0.9	+25	[illegible]
337F	300°	0.5	0.9	+25	[illegible]
339F	310°	0.5	0.9	+20	+37
208F	117°	0.8	1.5	−40	−73
222M	322°	1.0	1.9	+14	[illegible]
242M	333°	1.4	2.6	+12	[illegible]
243M	330°	1.4	2.6	+20	[illegible]
248M	325°	1.3	2.4	+24	+44
258M	317°	0.9	1.7	+23	+42
261M	331°	0.9	1.7	+19	[illegible]
278M	317°	0.7	1.3	+18	[illegible]
303M	243°	1.6	3.0	−23	−42
310M	341°	0.6	1.1	+20	+37
341M	317°	0.4	0.7	+18	+33
342M	317°	0.4	0.7	+18	[illegible]

All but three (208F, 237F, 303M) of the migrants ranged significantly shoalward from point of release and w[illegible] recaptured within 89 days from date of release. Migr[illegible] 208F moved quickly toward deeper water approximati[illegible] depth at first capture; migrant 237F, a large egg-bearing female, moved rapidly some 87 miles (161 km) in 20 d[illegible] to be recaptured near the head of Oceanographer Can[illegible] in only slightly deeper water; migrant 303M, a larg[illegible] male, moved 123 miles (228 km) in 76 days to be recaptured on the east flank of Hydrographer Canyon [illegible] significantly deeper water. These movements do not c[illegible] form to a working hypothesis of springtime shoalwar igration but they illustrate the kind of exceptions that ably arise in attempted classification of the ments of tagged animals over a short term; the long stance traveled by 237F and 303M, both at high rates eed, tend to infer directionality on their movements are inconsistent with our hypothesis; the close ment of the track bearings might well be coincidence, but a rational conclusion, nevertheless, is that racks are similar results of disoriented attempts to n to original release depth.

The exceptions noted above notwithstanding, the lance (25) of these migrants effected movements that highly consistent in directionality, time at large, distance. Inspection of Appendix Table 22 shows at all were recaptured within the range 20-89 days at t distances from point of release ranging from 22 to 48 (40.8-89.0 km); bearings of the net tracks are con- to the narrow range 300°-341° with effective shoal- g ranging from 17 to 25 fathoms (31.1-45.7 m). This icular group of defined migrants amply supports our iling hypothesis and serves to illustrate better than ther the concept of the outbound (shoalward) phase seasonal migration.

omposite Station 23 (See Figure 25 and ppendix Table 23)

Thirty-four recaptures have been reported from a mposite total of 301 releases near the east flank of er Canyon on 19 and 20 June 1969. Mean depth at capture was 61 fathoms (112 m); mean depth at lease was 82 fathoms (150 m). Twenty-eight lobsters reported by specific location and two by ap- imate location. Sex ratio at release was 139 females) to 162 males; the ratio at return was 20 females 9%) to 14 males.

ean time at large for all accountable (32) recoveries 249 days (0.7 yr); greatest time at large for a located vidual (848F), an egg-bearing female at release, was 6 days (1.4 yr) with recapture 16 miles (29.7 km) from nal release point.

ean distance traveled by individuals with specific pture locations (28) was 35 miles (64.9 km); eight in- viduals (576F, 728F, 771F, 562M, 564M, 767M, 769M, M) surpassed the 50-mile (92.7-km) range from point lease with two of these (728F, 797M) exceeding 100 iles (185 km). Maximum dispersion of 126 miles (234) westerly was accomplished by 728F while at large days (0.95 yr); this individual bore ripe external eggs ecapture which, coupled with zero growth over the riod at large, implies that egg deposition occurred tly after release.

nly four of the recaptures qualify as migrants; all ere recaptured in significantly shoaler water with at ast three of the four effecting large-scale movements relatively short term. Calculated bearing, ground d, and depth change of these migrants are given low:

Return no.	Bearing	Ground speed mi/day	Ground speed km/day	Depth change fathoms	Depth change meters
576F	313°	1.1	2.0	+59	+108
584F	344°	0.5	0.9	+51	+93
562M	285°	5.0	9.3	+52	+95
564M	282°	5.5	10.2	+50	+91

The net tracks exhibited by 576F and 548F approach the idealized view of directed shoalward movements; the tracks of 562M and 564M are good, in the comparative sense, but less than ideal in terms of the best vector toward shoaler water. These two migrants rank first and third for calculated ground speed among the 117 defined migrants.

Probable migrations are evident in the respective locations of at least four other individuals (767F, 769M, 797M, 771F); each of these lobsters was recaptured approximately 1 yr after release at depths (20-35 fathoms = 36.6-64.0 m) consistent with hypothesized summertime distribution. It should be noted that here, as elsewhere, perambulations beyond one season cannot be approximated by a straight-line track; this simple convention is probably a valid estimator in cases of defined migrants, but where movements are summed over two or more migration cycles, the track-line can be nothing more than a measure of temporal displacement from point of release.

Composite Station 24 (See Figure 26 and Appendix Table 24)

Twenty-two recaptures have been reported from a composite release of 173 lobsters 10 miles (18.5 km) west of Oceanographer Canyon on 19 and 22 June 1970. Mean depth at first capture was 59 fathoms (108 m); mean depth at release was 57 fathoms (104 m). Fifteen lobsters were reported by specific location and four by approximate location. Three recaptures were reported without location information of any kind. Sex ratio at release was 72 females (42%) to 101 males; the ratio at return was 14 females (64%) to 9 males.

Mean time at large for all accountable (22) recoveries was 290 days (0.8 yr); greatest time at large for a located individual (883F), a mature female at release, was 512 days (1.4 yr) with recapture 18 miles (33.4 km) from release point.

Mean distance traveled by individuals with specific capture locations (15) was 24 miles (44.5 km); two individuals (569F, 648M) surpassed the 50-mile (92.7-km) radius of dispersion. Recapture 569F, the only qualified migrant among the returns, moved 74 miles (137 km) southwesterly in 16 days (4.6 miles/day = 8.5 km/day) to equivalent depth near Veatch Canyon; recapture 648M was taken 136 miles (252 km) westerly near Block Canyon following 207 days at large.

Composite Station 25 (See Figure 27 and Appendix Table 25)

Ten recaptures have been reported from a composite release of 60 trap-caught lobsters near Block Canyon on 6 and 7 January 1971. Twenty-four were captured, tagged, and released at 115 fathoms (210 m); 36 others were taken, tagged, and released at 212 fathoms (388 m). All recaptures were reported by specific location. Sex ratio at release was 30 females (50%) to 30 males; the ratio at recapture was 6 females (60%) to 4 males.

Mean time at large for the 10 recoveries was 285 days (0.8 yr); greatest time at large for a given individual (920M), a mature male at release, was 530 days (1.5 yr) with subsequent recapture 4 miles (7.4 km) from release point.

Mean distance ranged by the 10 recaptures was 15 miles (27.8 km); maximum dispersion of 54 miles (100 km) was attained by 798F while at large 163 days (0.4 yr); all other dispersions were 29 miles (53.7 km) or less with two (735F, 734M) recaptured at original release locations following some 6 mo at large.

None of the recaptures meet the migrant criteria as defined.

Composite Station 26 (See Appendix Table 26)

Only a single recapture has been reported from a composite total of 54 releases (trap-caught) southwest of Hudson Canyon on 25 January and 21 February 1971. The initial group of 50 lobsters was caught and released at 225 fathoms (412 m); the second group of four was caught and released at 300 fathoms (549 m). Sex ratio at release was 17 females (31%) to 37 males.

The single recovery (647M), a mature male at release, was at large 112 days (0.3 yr) prior to recapture at an unspecified location.

Composite Station 27 (See Figure 28 and Appendix Table 27)

Eleven recaptures have been reported from a composite release of 194 trap-caught lobsters 15 miles (27.8 km) south of Baltimore Canyon on 7, 8, 10, and 11 February 1971. Forty-seven were captured and released at 185 fathoms (338 m); 24 were captured and released at 292 fathoms (534 m); 123 were captured and released at 150 fathoms (274 m). All of the recaptures were reported by specific location. The sex ratio at release was 99 females (51%) to 95 males; the ratio at return was 6 females (54%) to 5 males.

Mean time at large for all recoveries was 452 days (1.3 yr); greatest time at large was 620 days (1.7 yr) with net displacement of only 4 miles (7.4 km).

Mean distance traveled by the 11 recaptures was 24 miles (44.5 km); two individuals (740F, 917F) exceeded the 50-mile (92.7-km) range. Maximum dispersion was attained by 917F which was taken in a coastal trap fishery near Cape May, N.J., some 71 miles (132 km) from release location.

None of the recaptures meet migrant criteria.

Composite Station 28 (See Appendix Table 28)

Three recaptures have been reported from a single point release of 29 trap-caught lobsters 25 miles (46.3 km) southwest of Hudson Canyon on 22 February 1971 Capture and release depth was 250 fathoms (457 m ratio at release was 14 females (48%) to 15 males.

Mean time at large for the three recoveries was 18 days (0.5 yr); greatest time at large was 479 days (1.3 yr with only 9 miles (16.7 km) displacement from re locality.

Mean distance ranged by the three recoveries was onl 7.6 miles (14.1 km), the range being 7-9 miles (13.0 km).

None of these recaptures meet the migrant criter a defined.

Composite Station 29 (See Figure 29 and Appendix Table 29)

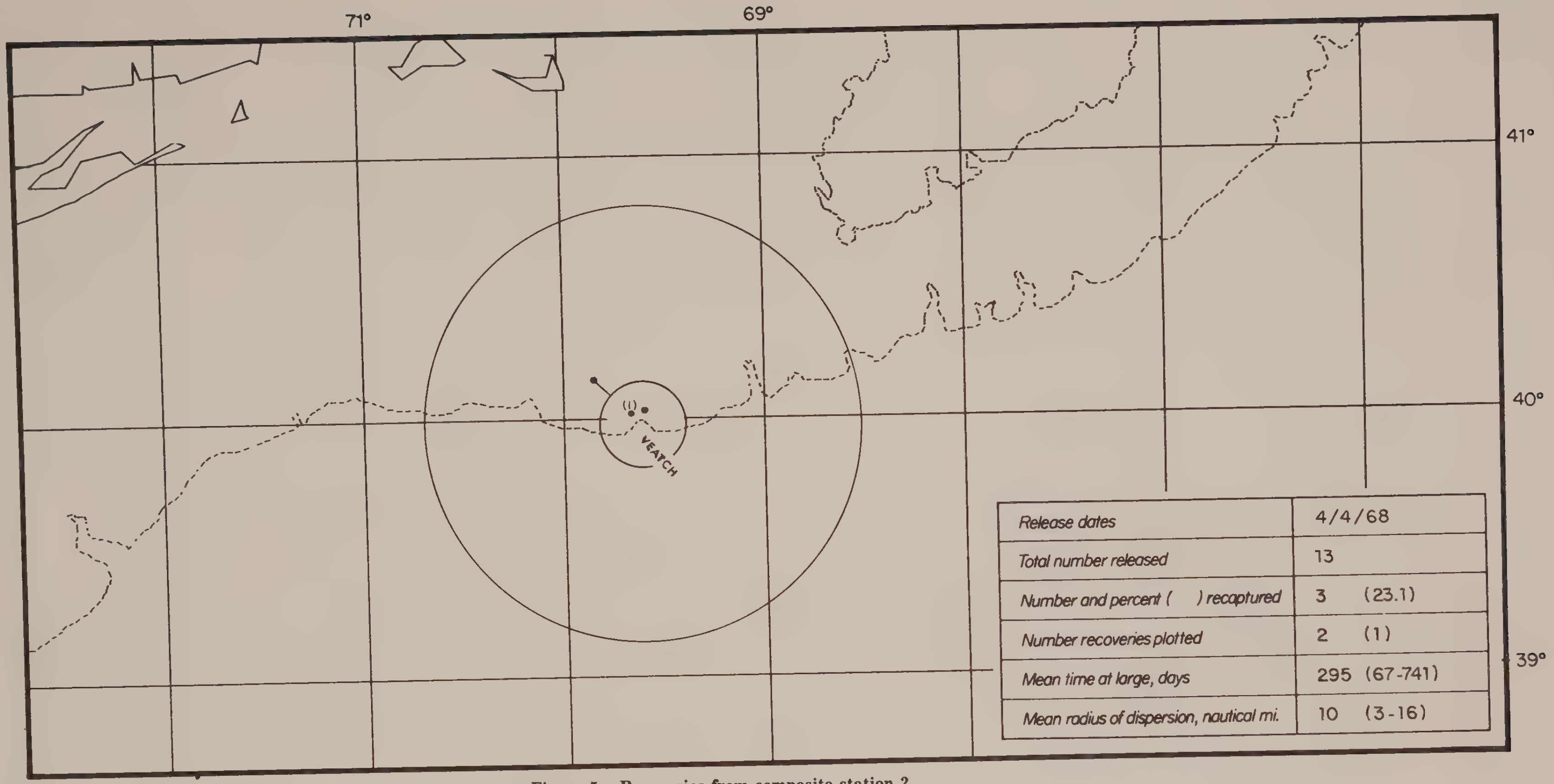
One hundred fifty-five recaptures have been rep from a composite release of 805 trap-caught lobste Veatch Canyon on 9 and 10 May 1971.

This series of releases was made by one of us (Richar A. Cooper) while participating as scientific observer ing commercial trap-fishing operations of the FV *Fox* owned and operated by the Prelude Lobster Corpora tion of Westport, Mass. The lobsters that were ta were, for the most part, either sublegal by size, or bearing females, and would normally have been discard ed as the traps were hauled and emptied. This taggin strategy was not used on any other cruise. All c lobsters were trawl-caught or trapped (comp stations 25, 26, 27, 28) by research vessels previousl named; among these trap-caught lobsters all that wer viable at capture were tagged and released with th ception of those which were dead or moribund (< after the posttagging holding period.

One hundred fifty of the tagged lobsters were capt and released at 60 fathoms (110 m); the second grou 655 was captured and released at 55 fathoms (101 Sixty-three of the recaptures were reported by specifi location, 83 by approximate location, and 9 without l tion information of any kind. Sex ratio at release was females (77%) to 184 males; the ratio of recaptures was 105 females (68%) to 50 males.

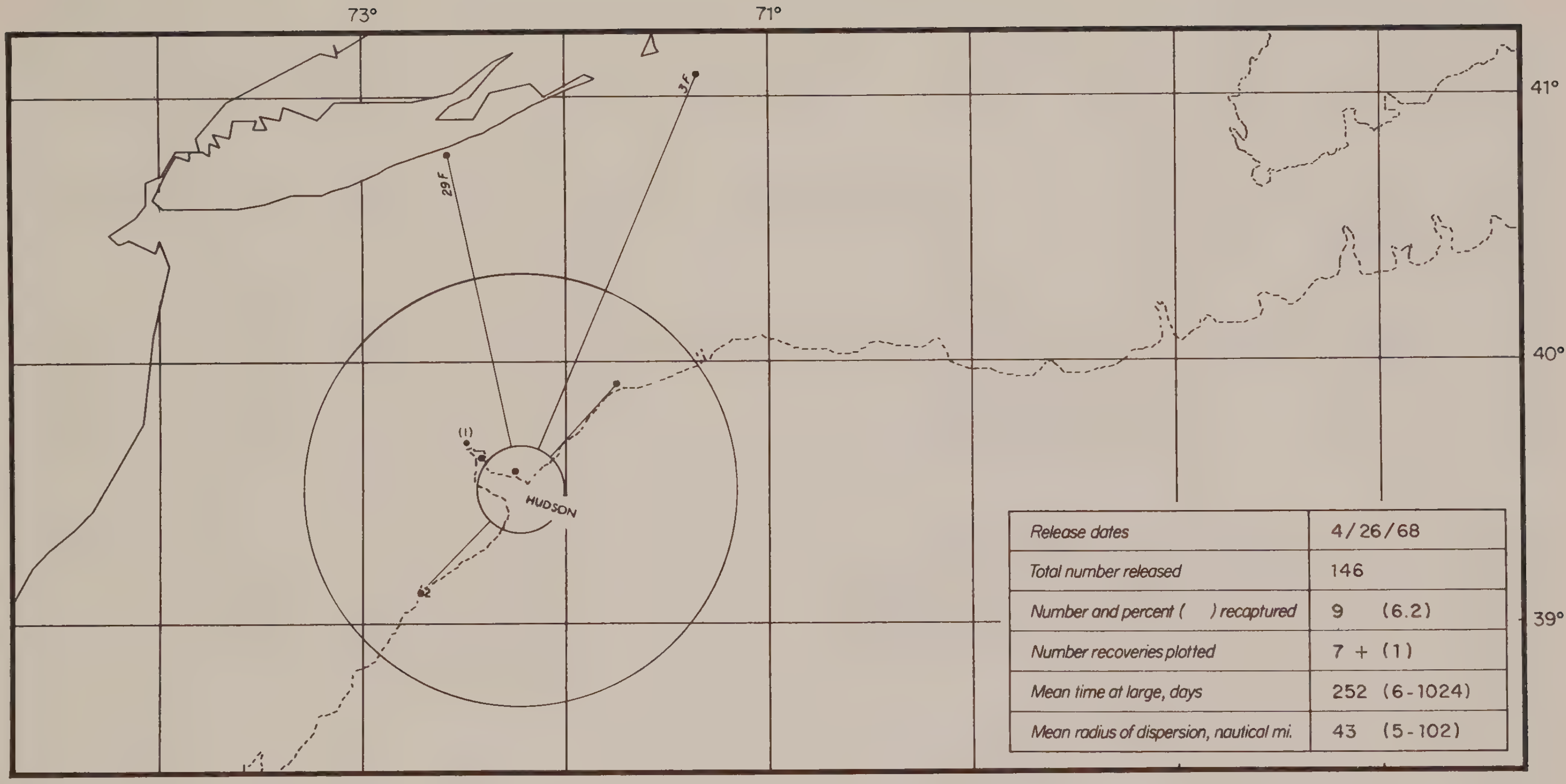
Mean time at large for all accountable (154) recove was 183 days (0.5 yr); greatest time at large for a loc individual (953F), an immature female at release, was 492 days (1.3 yr) with recapture 18 miles (33.4 km) from release point.

Mean distance traveled by individuals with spe capture locations (63) was 15 miles (27.8 km); five lobsters (721F, 738F, 926F, 758M, 895M) surpassed 50-mile (92.7-km) range with each of the two males ceeding 100 miles (185 km). Maximum dispersion of miles (206 km) northerly to Cuttyhunk Island was attained by 758M while at large 108 days; this migrat (by prior definition) into the coastal trap fishery further example of the evident, but unmeasured, annual recruitment to coastal stocks by lobsters of offshore origin. The net dispersion of 895M over 221 days t point 102 miles (189 km) westerly could conceivably h been the summation of a shoalward migration such as



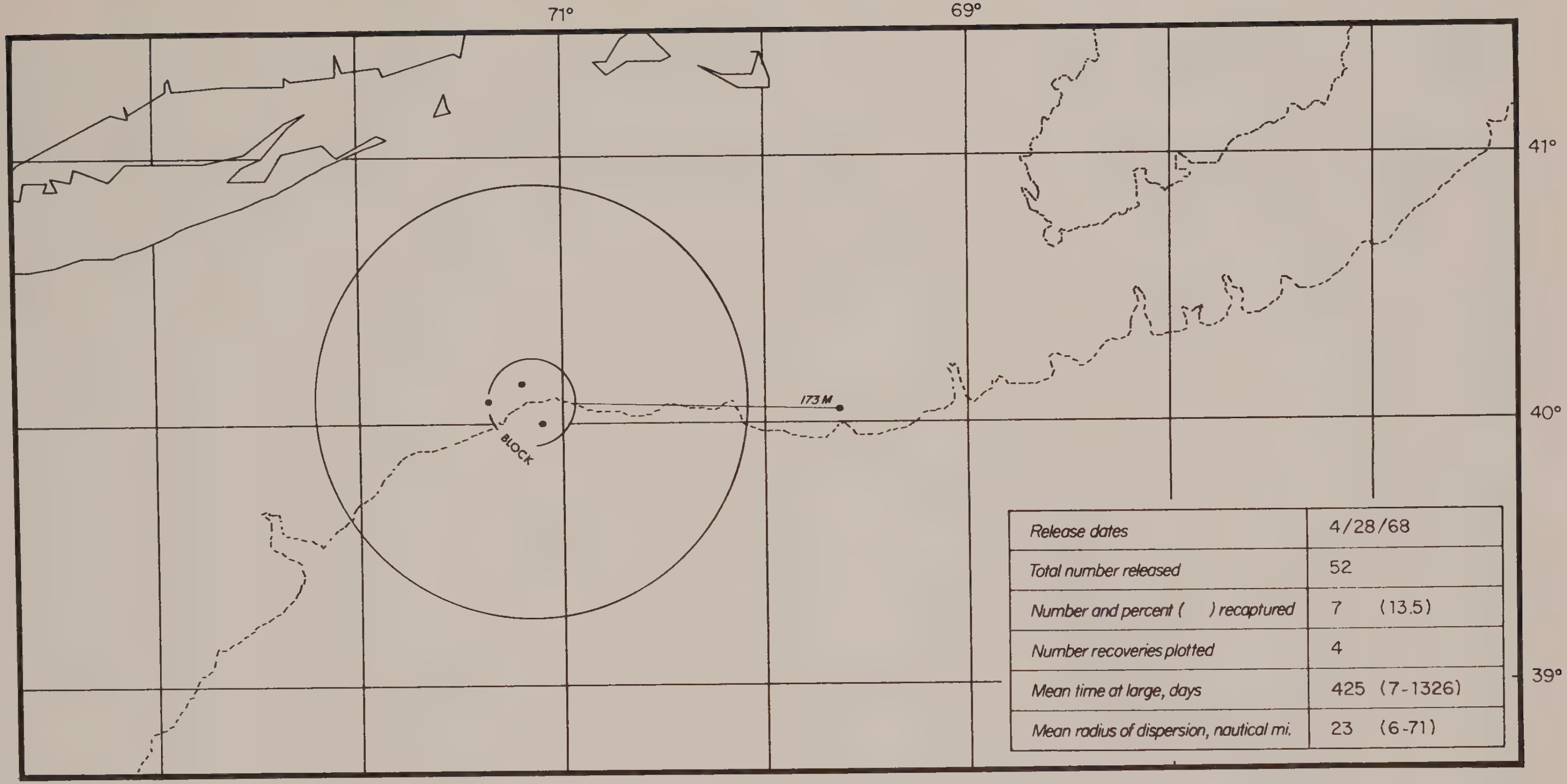
Release dates	4/4/68
Total number released	13
Number and percent ( ) recaptured	3 (23.1)
Number recoveries plotted	2 (1)
Mean time at large, days	295 (67-741)
Mean radius of dispersion, nautical mi.	10 (3-16)

Figure 5.—Recoveries from composite station 2.


73°
71°
41°
40°
39°
3F
29F
(1)
2
HUDSON

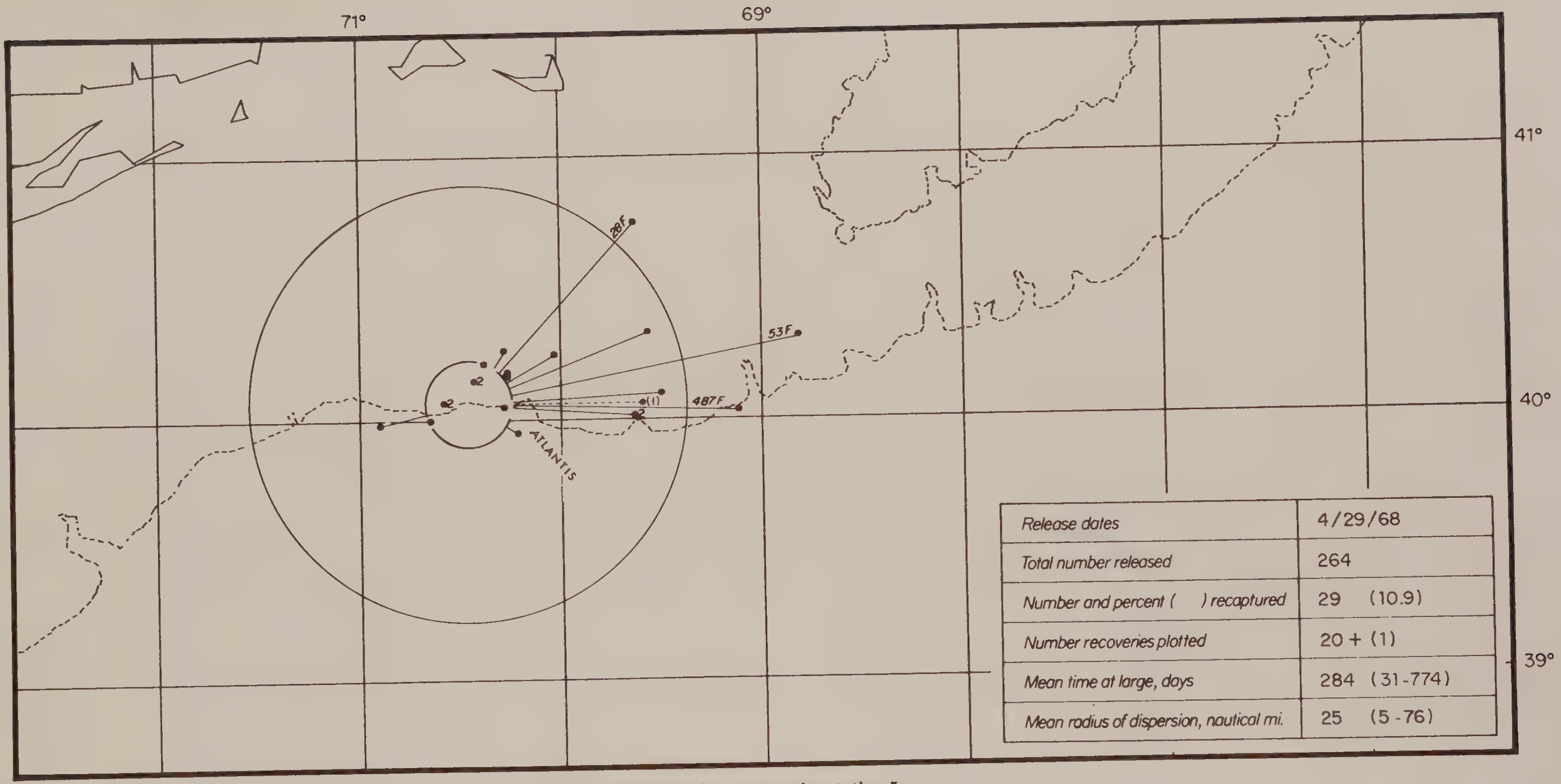
Release dates	4/26/68
Total number released	146
Number and percent ( ) recaptured	9 (6.2)
Number recoveries plotted	7 + (1)
Mean time at large, days	252 (6-1024)
Mean radius of dispersion, nautical mi.	43 (5-102)

Figure 6.—Recoveries from composite station 3.



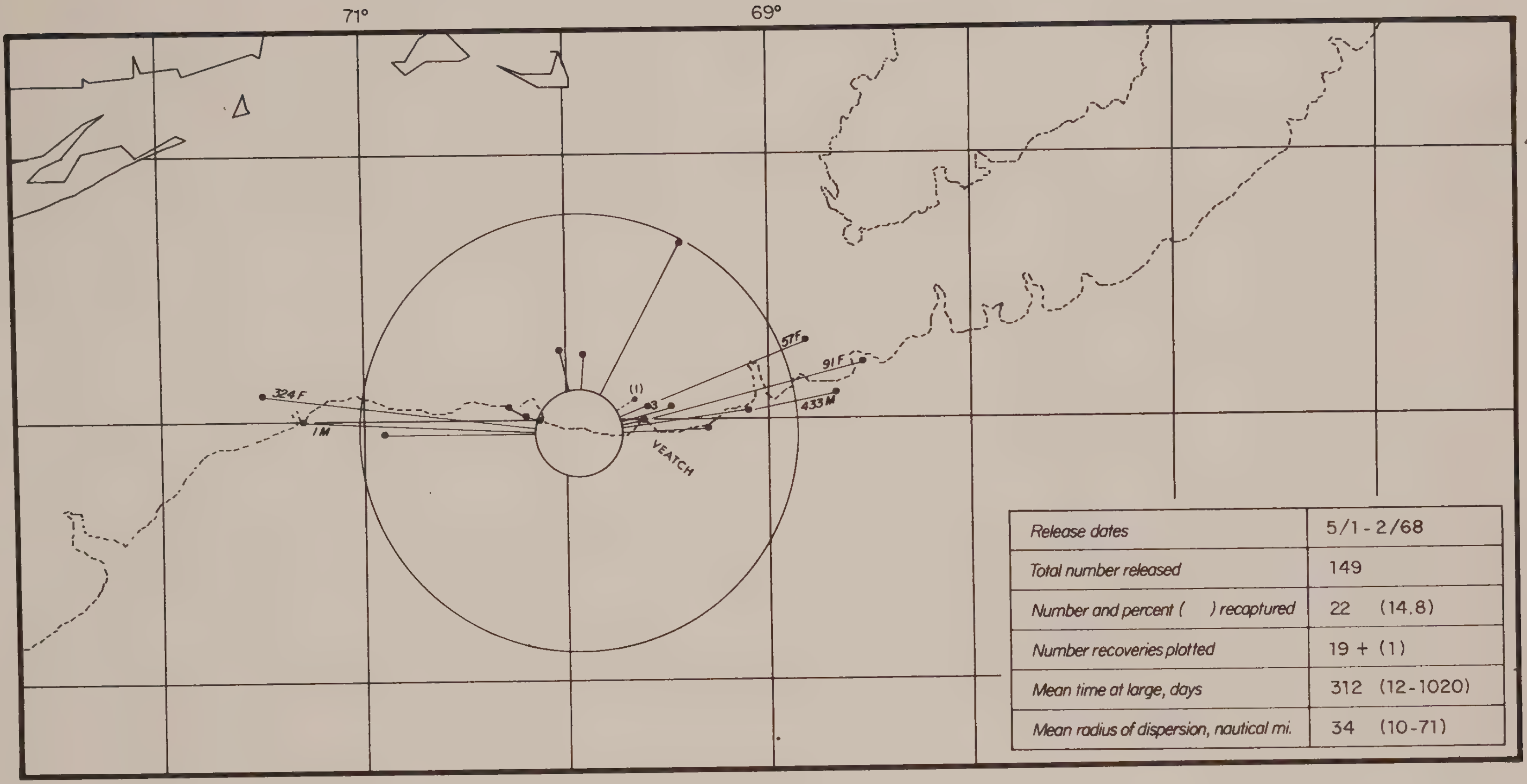
Release dates	4/28/68
Total number released	52
Number and percent ( ) recaptured	7 (13.5)
Number recoveries plotted	4
Mean time at large, days	425 (7-1326)
Mean radius of dispersion, nautical mi.	23 (6-71)

Figure 7.—Recoveries from composite station 4.


71°
69°
41°
40°
39°
28F
53F
487F
(1)
2
2
2
2
ATLANTIS

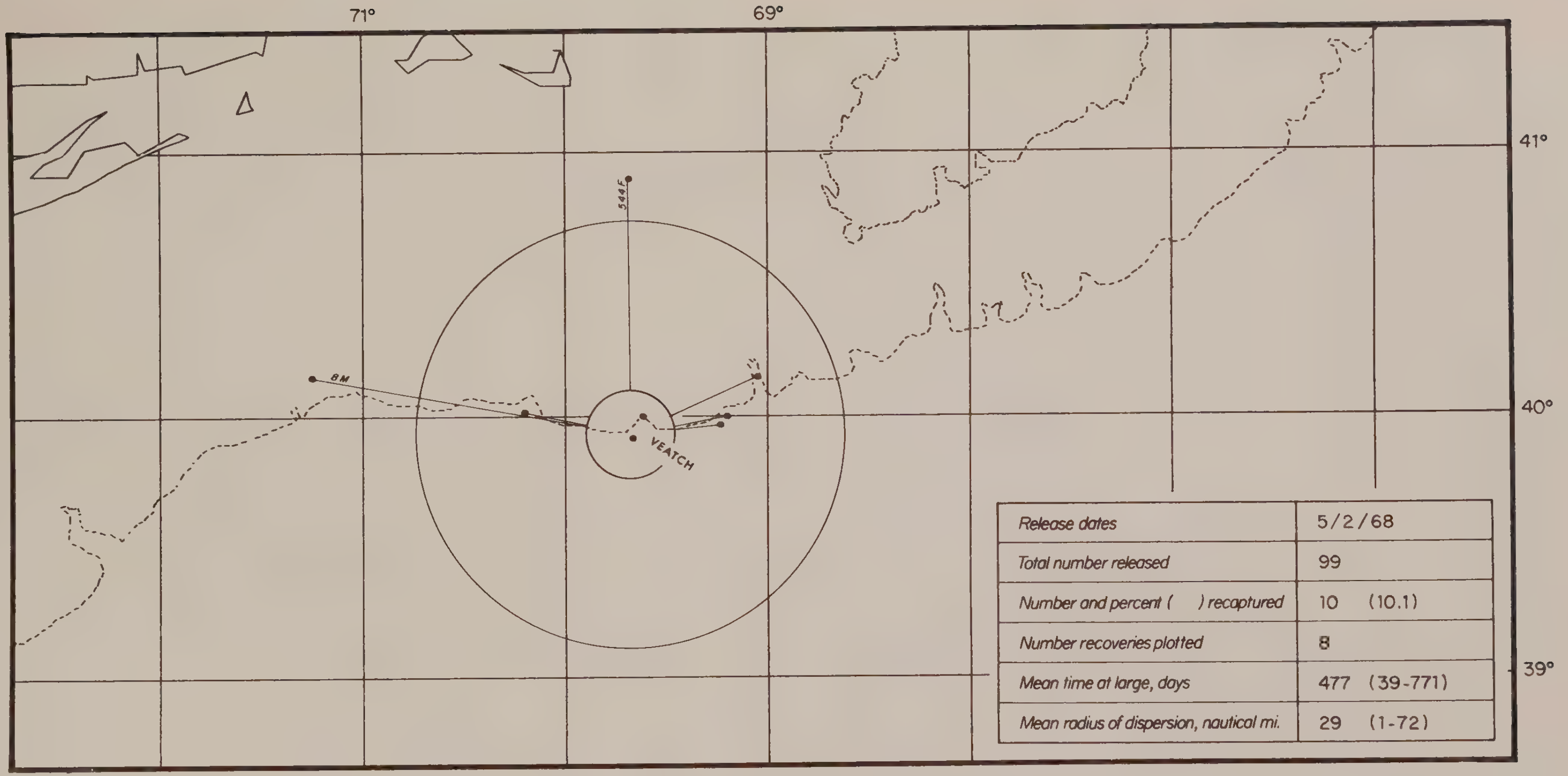
Release dates	4/29/68
Total number released	264
Number and percent ( ) recaptured	29 (10.9)
Number recoveries plotted	20 + (1)
Mean time at large, days	284 (31-774)
Mean radius of dispersion, nautical mi.	25 (5-76)

Figure 8.—Recoveries from composite station 5.


71°
69°
41°
40°
39°
324 F
1 M
(1)
3
57F
91 F
433 M
VEATCH

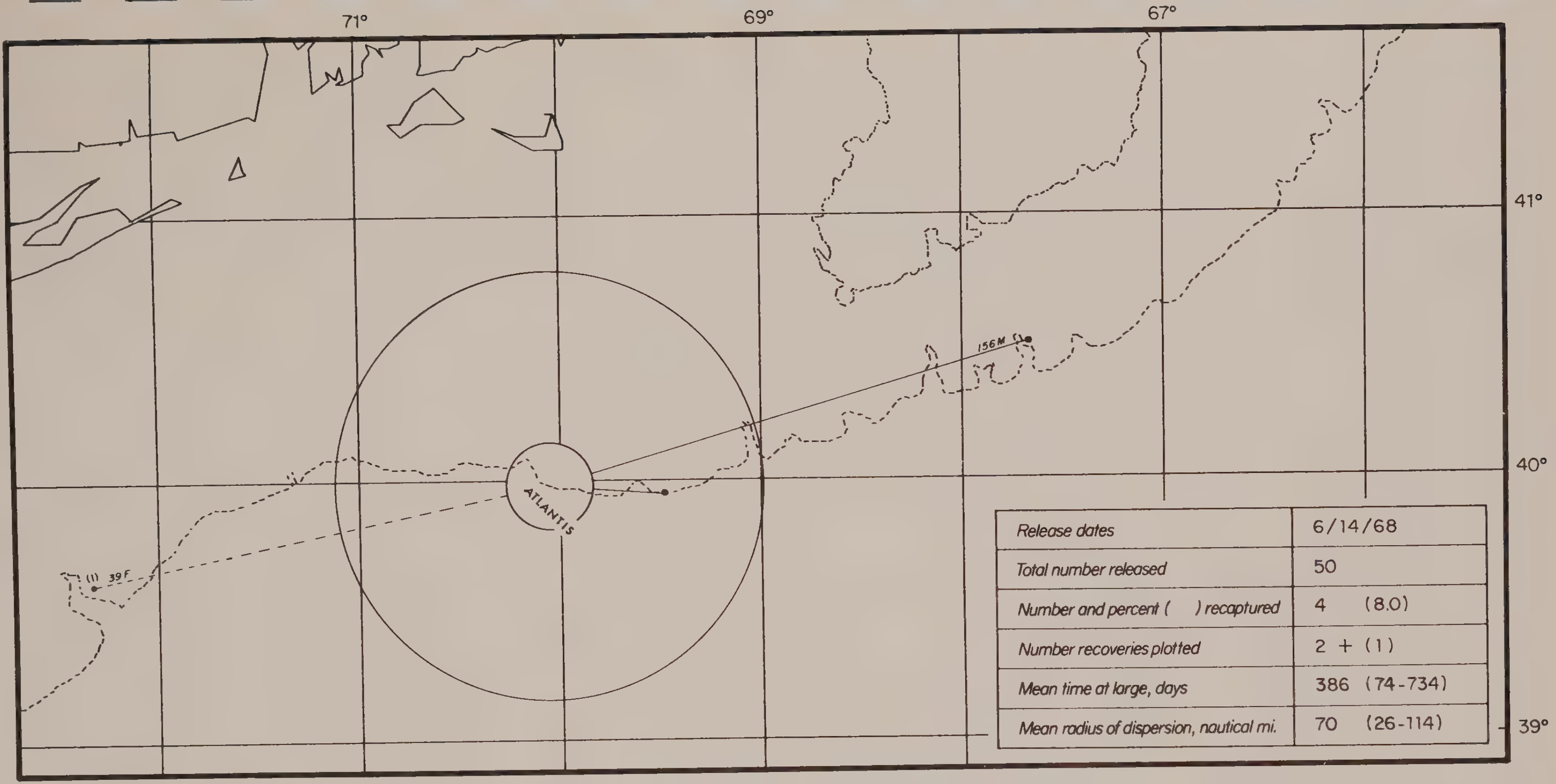
Release dates	5/1-2/68
Total number released	149
Number and percent ( ) recaptured	22 (14.8)
Number recoveries plotted	19 + (1)
Mean time at large, days	312 (12-1020)
Mean radius of dispersion, nautical mi.	34 (10-71)

Figure 9.—Recoveries from composite station 6.


71°
69°
41°
40°
39°
544F
8M
VEATCH

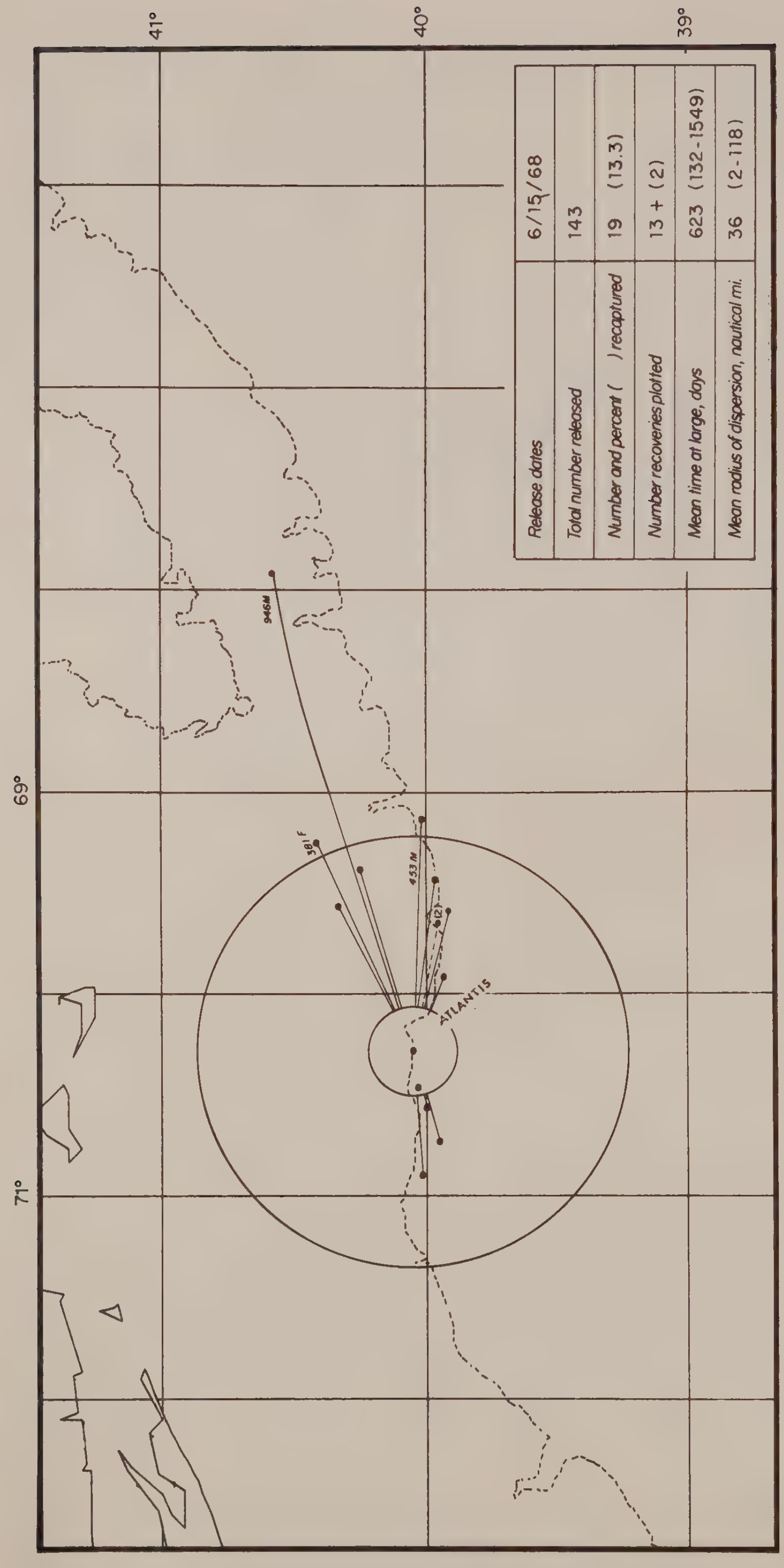
Release dates	5/2/68
Total number released	99
Number and percent ( ) recaptured	10 (10.1)
Number recoveries plotted	8
Mean time at large, days	477 (39-771)
Mean radius of dispersion, nautical mi.	29 (1-72)

Figure 10.—Recoveries from composite station 7.


71°
69°
67°
41°
40°
39°
156M
ATLANTIS
(1) 39F

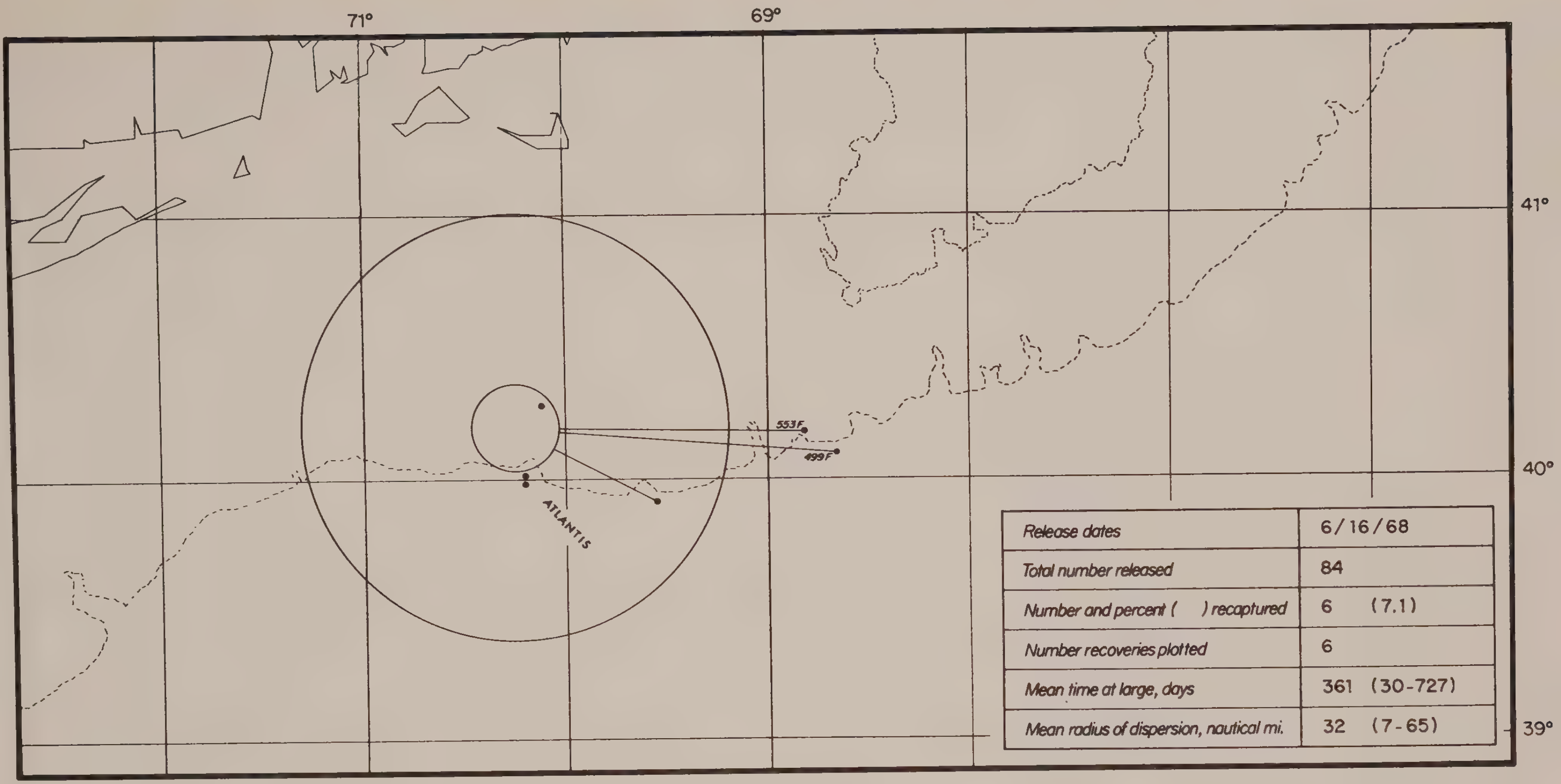
Release dates	6/14/68
Total number released	50
Number and percent ( ) recaptured	4 (8.0)
Number recoveries plotted	2 + (1)
Mean time at large, days	386 (74-734)
Mean radius of dispersion, nautical mi.	70 (26-114)

Figure 11.—Recoveries from composite station 8.


41°
40°
39°
71°
69°
946M
381F
453M
(2)
ATLANTIS

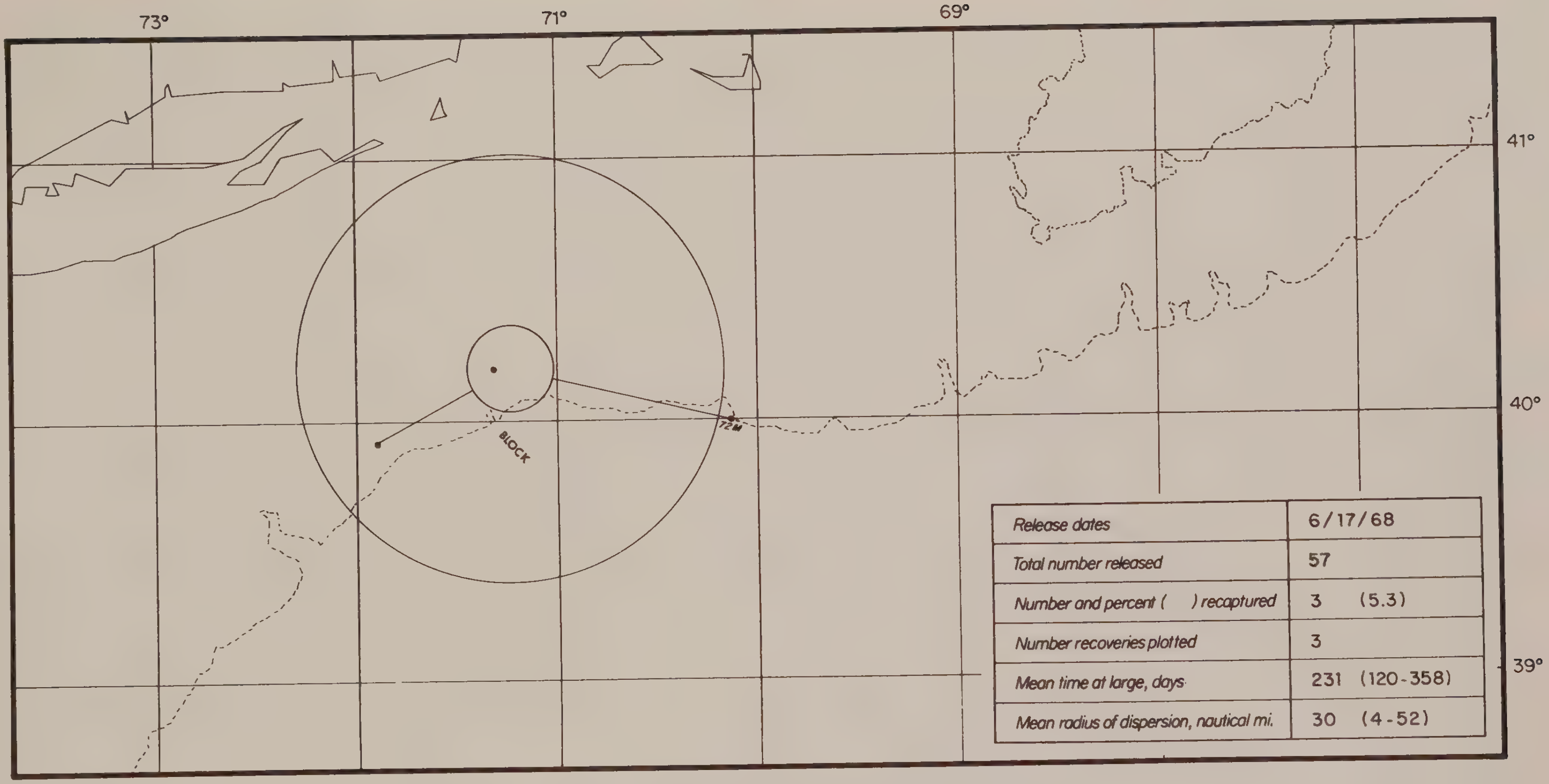
Release dates	6/15/68
Total number released	143
Number and percent ( ) recaptured	19 (13.3)
Number recoveries plotted	13 + (2)
Mean time at large, days	623 (132-1549)
Mean radius of dispersion, nautical mi.	36 (2-118)

Figure 12.—Recoveries from composite station 9.


71°
69°
41°
40°
39°
553F
499F
ATLANTIS

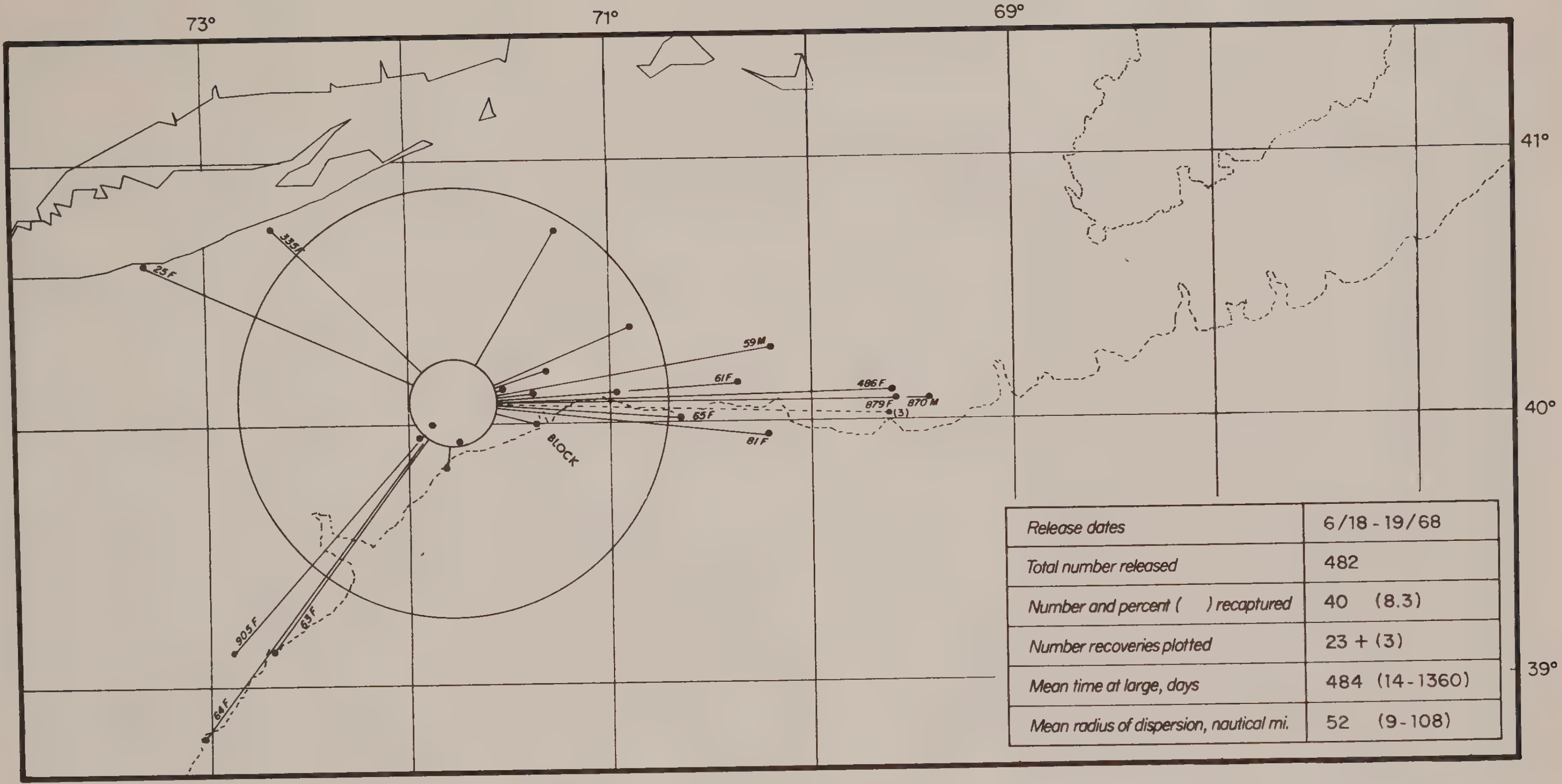
Release dates	6/16/68
Total number released	84
Number and percent ( ) recaptured	6 (7.1)
Number recoveries plotted	6
Mean time at large, days	361 (30-727)
Mean radius of dispersion, nautical mi.	32 (7-65)

Figure 13.—Recoveries from composite station 11.



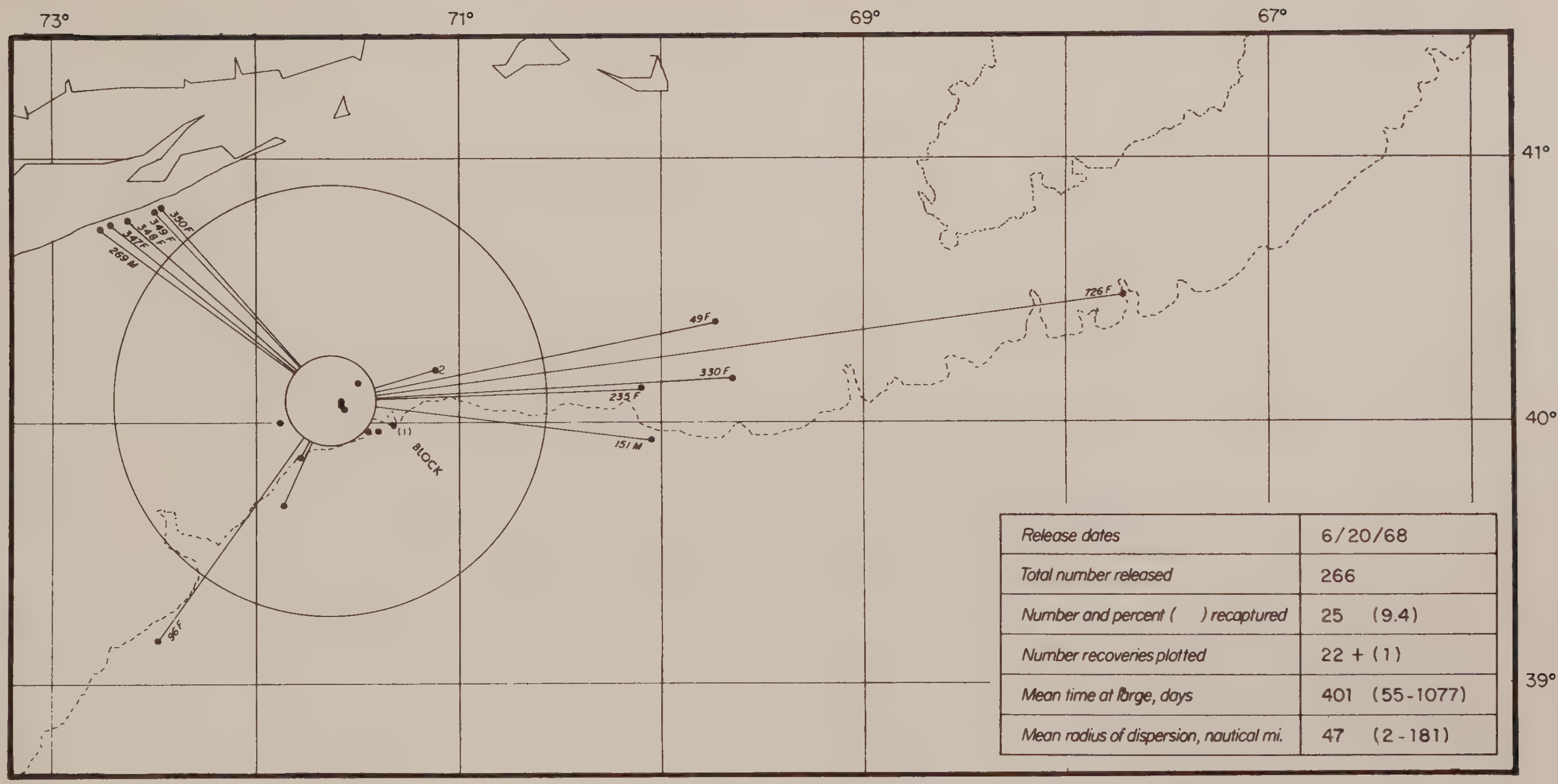
Release dates	6/17/68
Total number released	57
Number and percent ( ) recaptured	3 (5.3)
Number recoveries plotted	3
Mean time at large, days	231 (120-358)
Mean radius of dispersion, nautical mi.	30 (4-52)

Figure 14.—Recoveries from composite station 12.


73°
71°
69°
41°
40°
39°
335F
25F
59M
61F
486F
879F
870M
(3)
65F
81F
BLOCK
905F
63F
64F

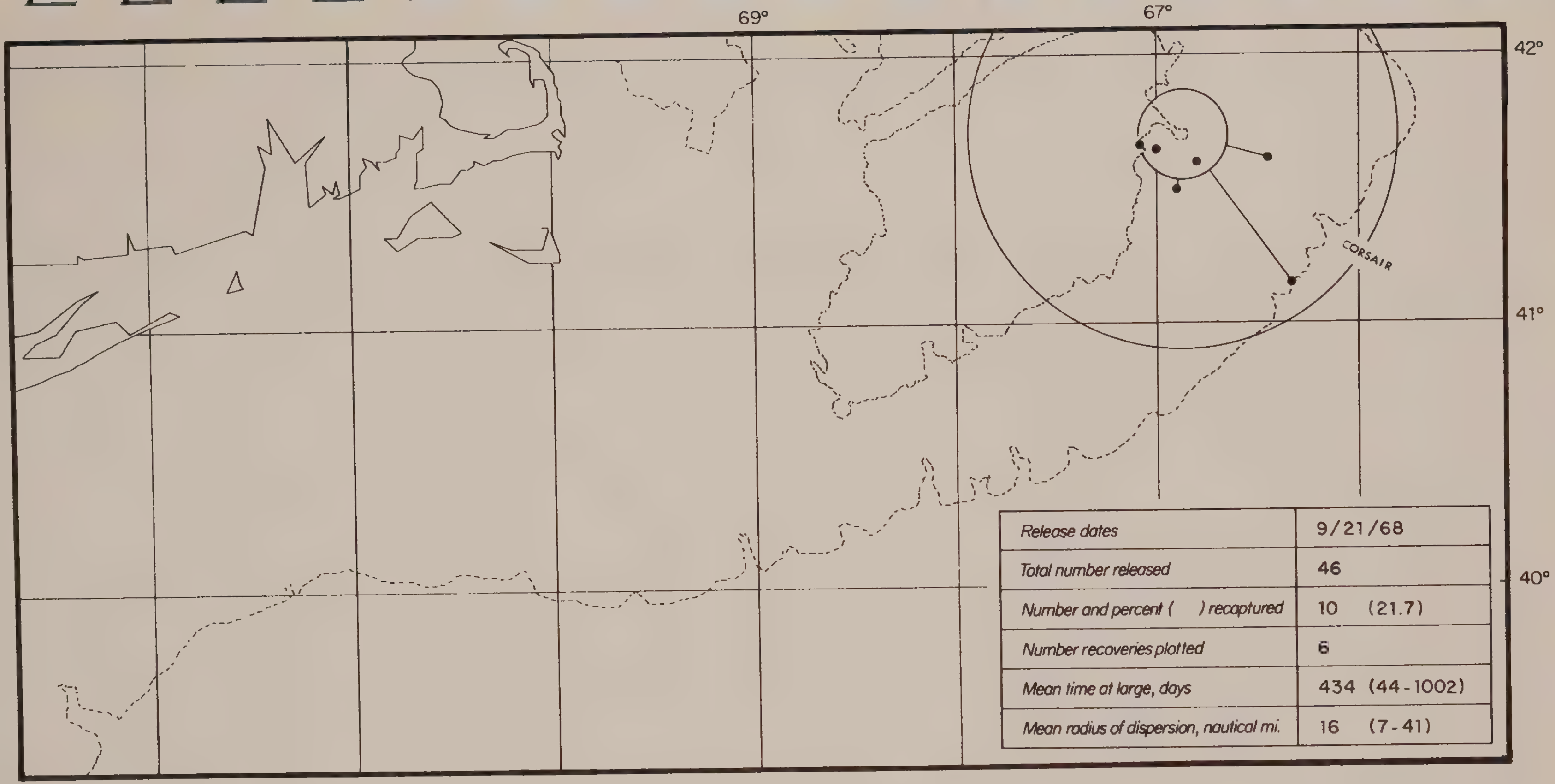
Release dates	6/18 - 19/68
Total number released	482
Number and percent ( ) recaptured	40 (8.3)
Number recoveries plotted	23 + (3)
Mean time at large, days	484 (14-1360)
Mean radius of dispersion, nautical mi.	52 (9-108)

Figure 15.—Recoveries from composite station 13.


73°
71°
69°
67°
41°
40°
39°
350F
349F
348F
347F
269M
49F
726F
330F
235F
151M
2
(1)
BLOCK
96F

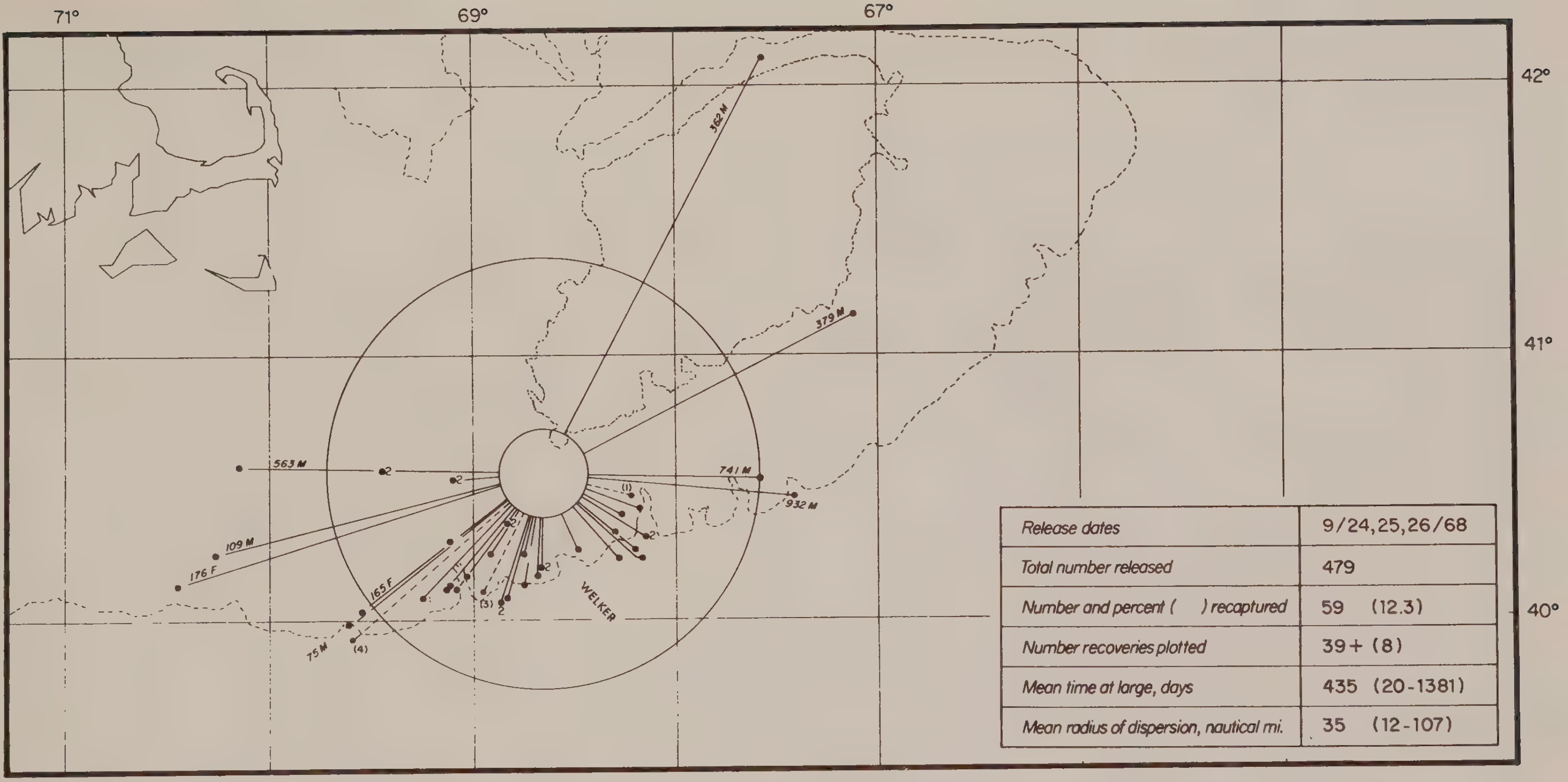
Release dates	6/20/68
Total number released	266
Number and percent ( ) recaptured	25 (9.4)
Number recoveries plotted	22 + (1)
Mean time at large, days	401 (55-1077)
Mean radius of dispersion, nautical mi.	47 (2-181)

Figure 16.—Recoveries from composite station 14.



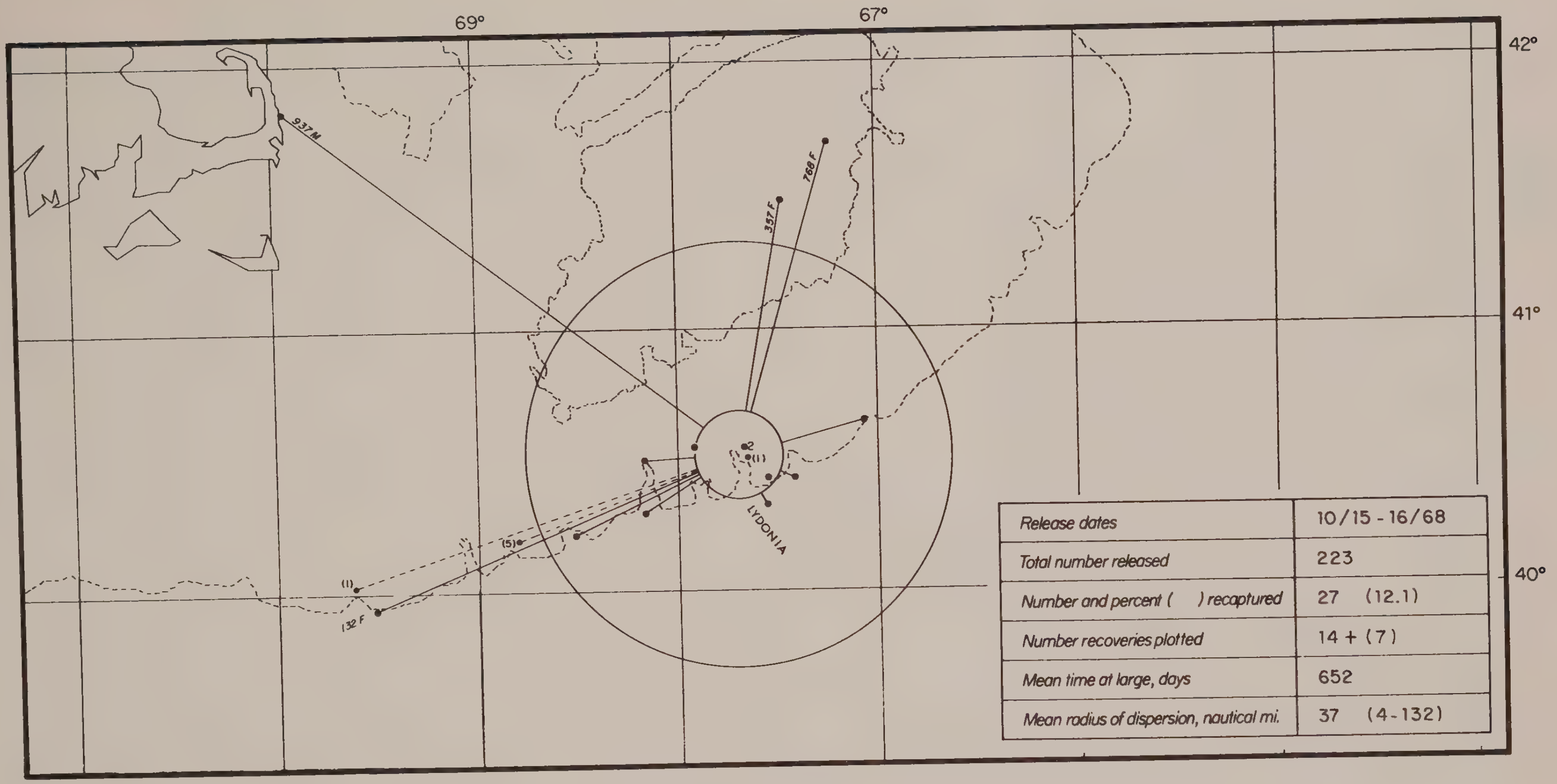
Release dates	9/21/68
Total number released	46
Number and percent ( ) recaptured	10 (21.7)
Number recoveries plotted	6
Mean time at large, days	434 (44-1002)
Mean radius of dispersion, nautical mi.	16 (7-41)

Figure 17.—Recoveries from composite station 15.


71°
69°
67°
42°
41°
40°
362 M
379 M
741 M
932 M
563 M
109 M
176 F
165 F
75 M
(4)
(3)
(1)
2
WELKER

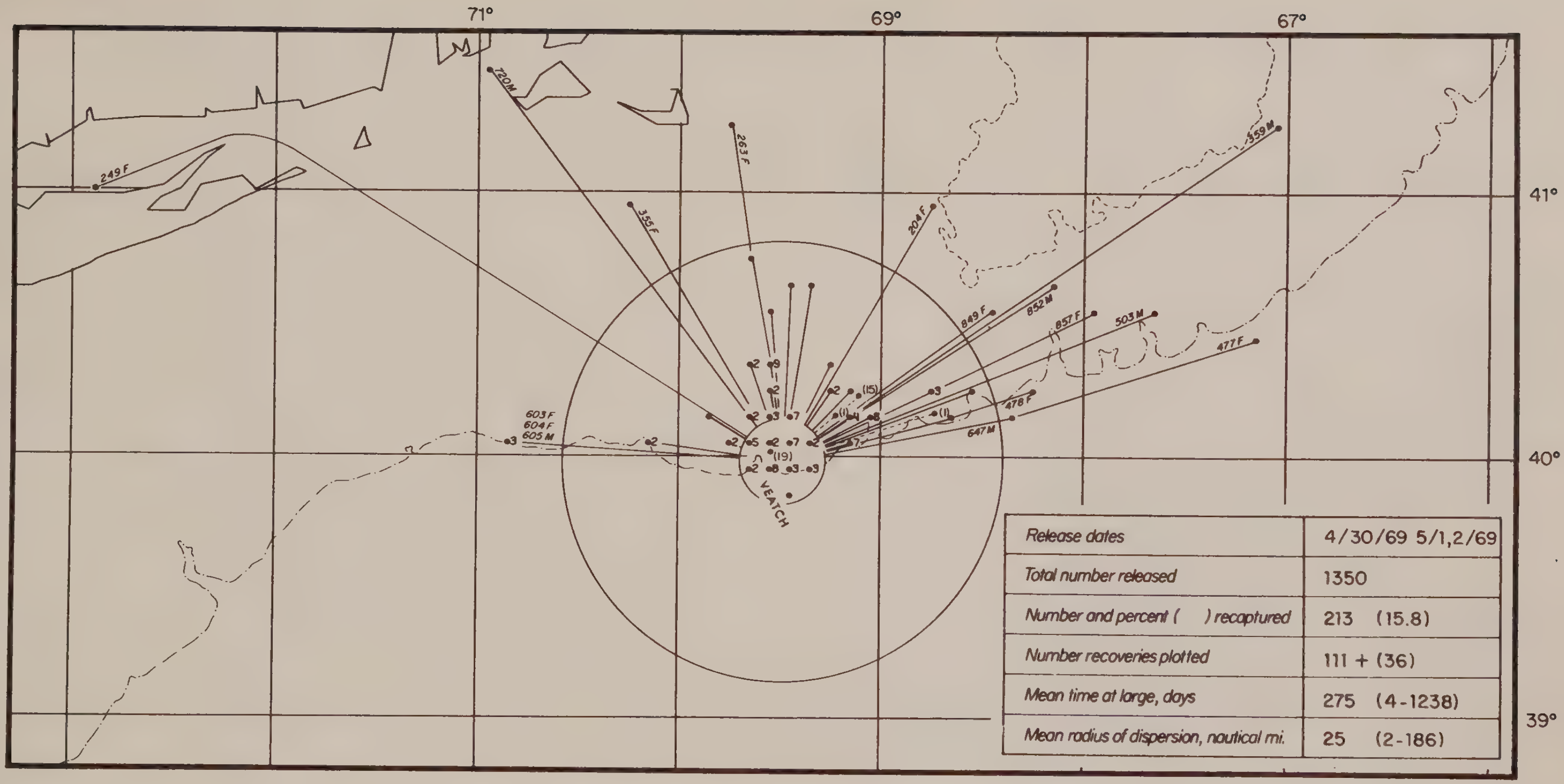
Release dates	9/24,25,26/68
Total number released	479
Number and percent ( ) recaptured	59 (12.3)
Number recoveries plotted	39+ (8)
Mean time at large, days	435 (20-1381)
Mean radius of dispersion, nautical mi.	35 (12-107)

Figure 18.—Recoveries from composite station 16.


69°
67°
42°
41°
40°
937 M
357 F
768 F
132 F
(1)
(5)
2
(1)
LYDONIA

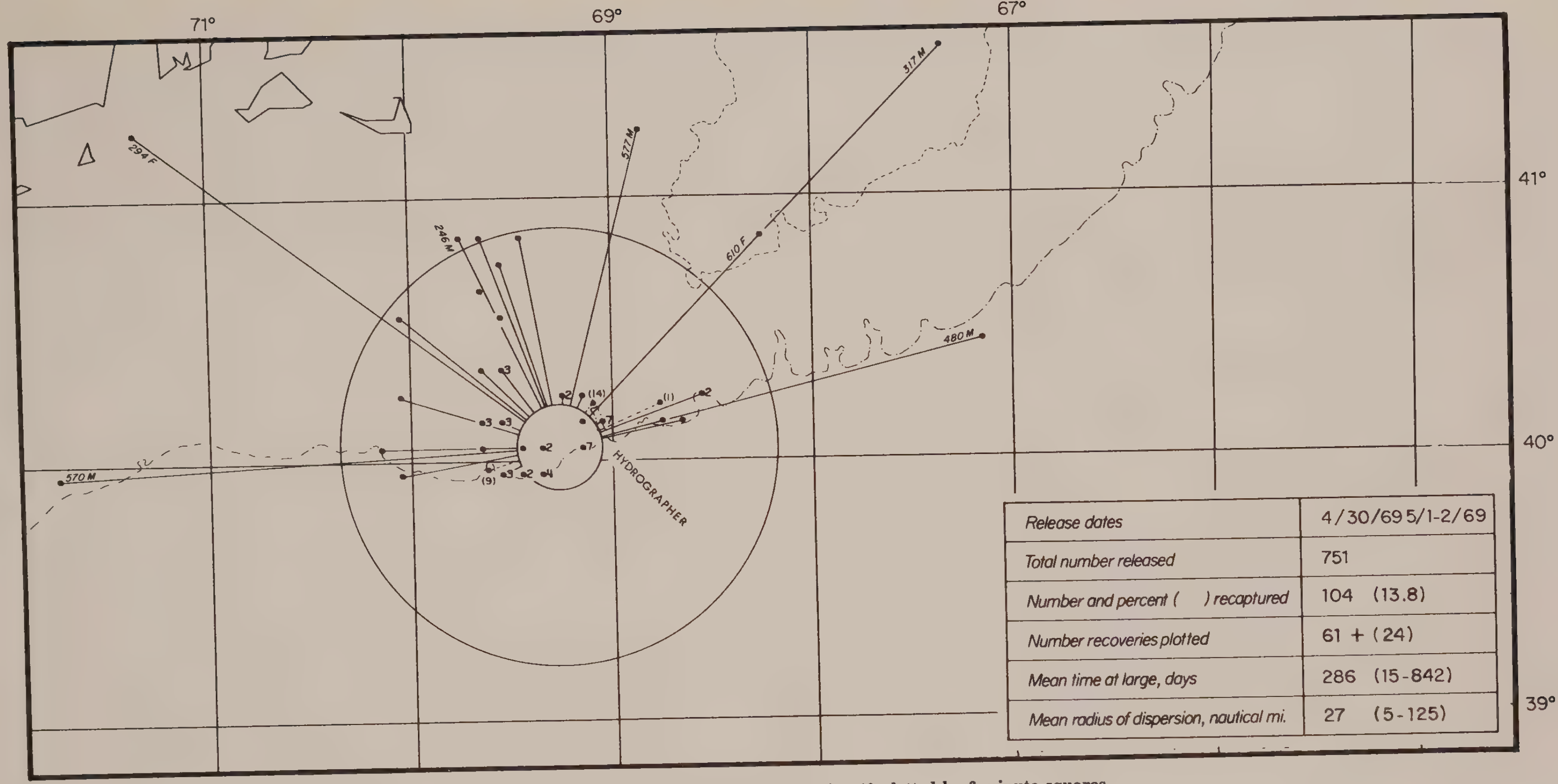
Release dates	10/15 - 16/68
Total number released	223
Number and percent ( ) recaptured	27 (12.1)
Number recoveries plotted	14 + (7)
Mean time at large, days	652
Mean radius of dispersion, nautical mi.	37 (4-132)

Figure 19.—Recoveries from composite station 17.


71°
69°
67°
41°
40°
39°
720M
249F
355F
263F
204F
359M
849F
852M
857F
503M
477F
478F
647M
603F
604F
605M
VEATCH
(19)
(15)
(1)

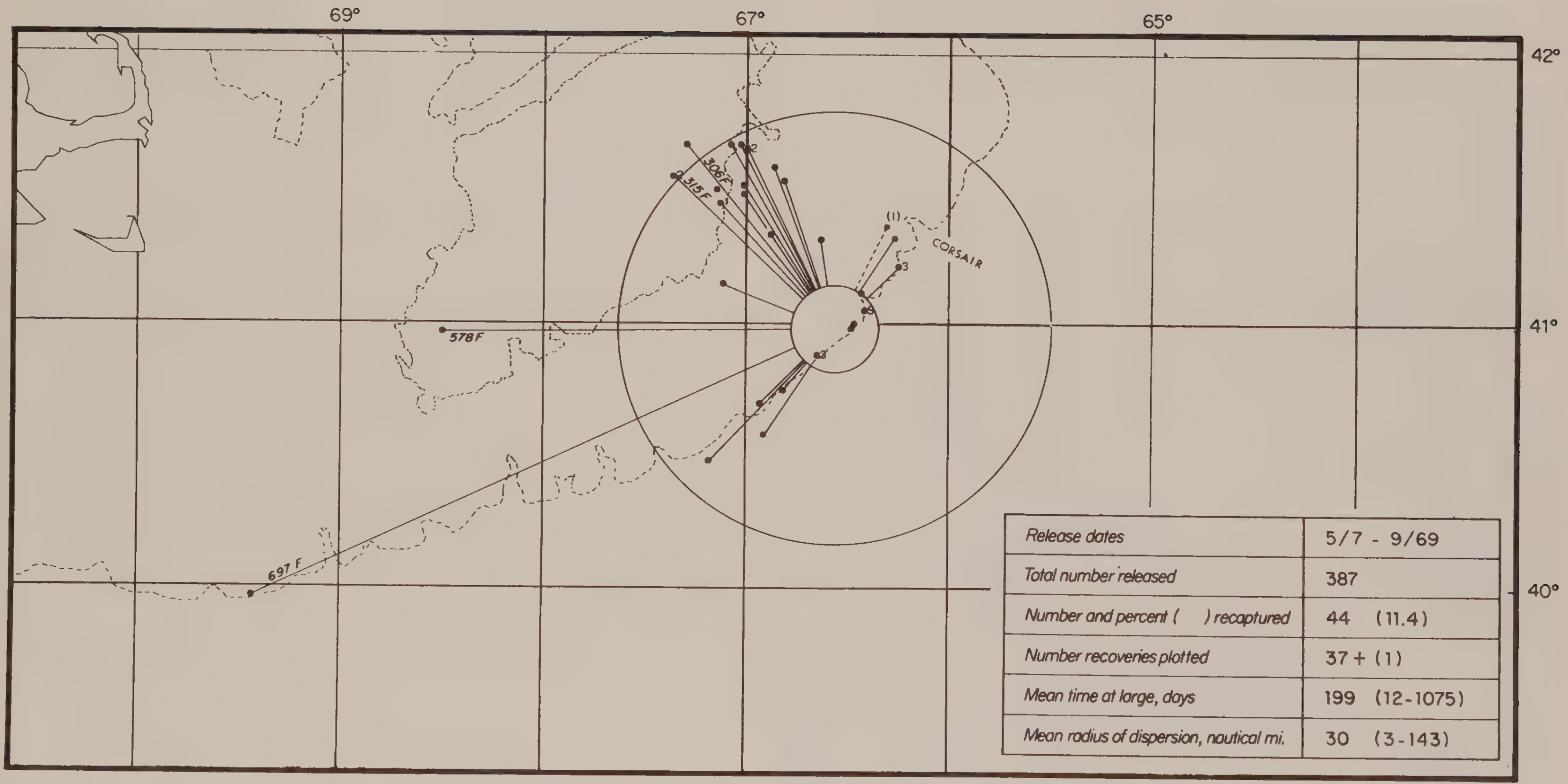
Release dates	4/30/69 5/1,2/69
Total number released	1350
Number and percent ( ) recaptured	213 (15.8)
Number recoveries plotted	111 + (36)
Mean time at large, days	275 (4-1238)
Mean radius of dispersion, nautical mi.	25 (2-186)

Figure 20.—Recoveries from composite station 18 plotted by 6-minute squares.


71°
69°
67°
41°
40°
39°
294 F
577 M
317 M
610 F
480 M
246 M
570 M
HYDROGRAPHER
(14)
(1)
(9)
2
3
7
4

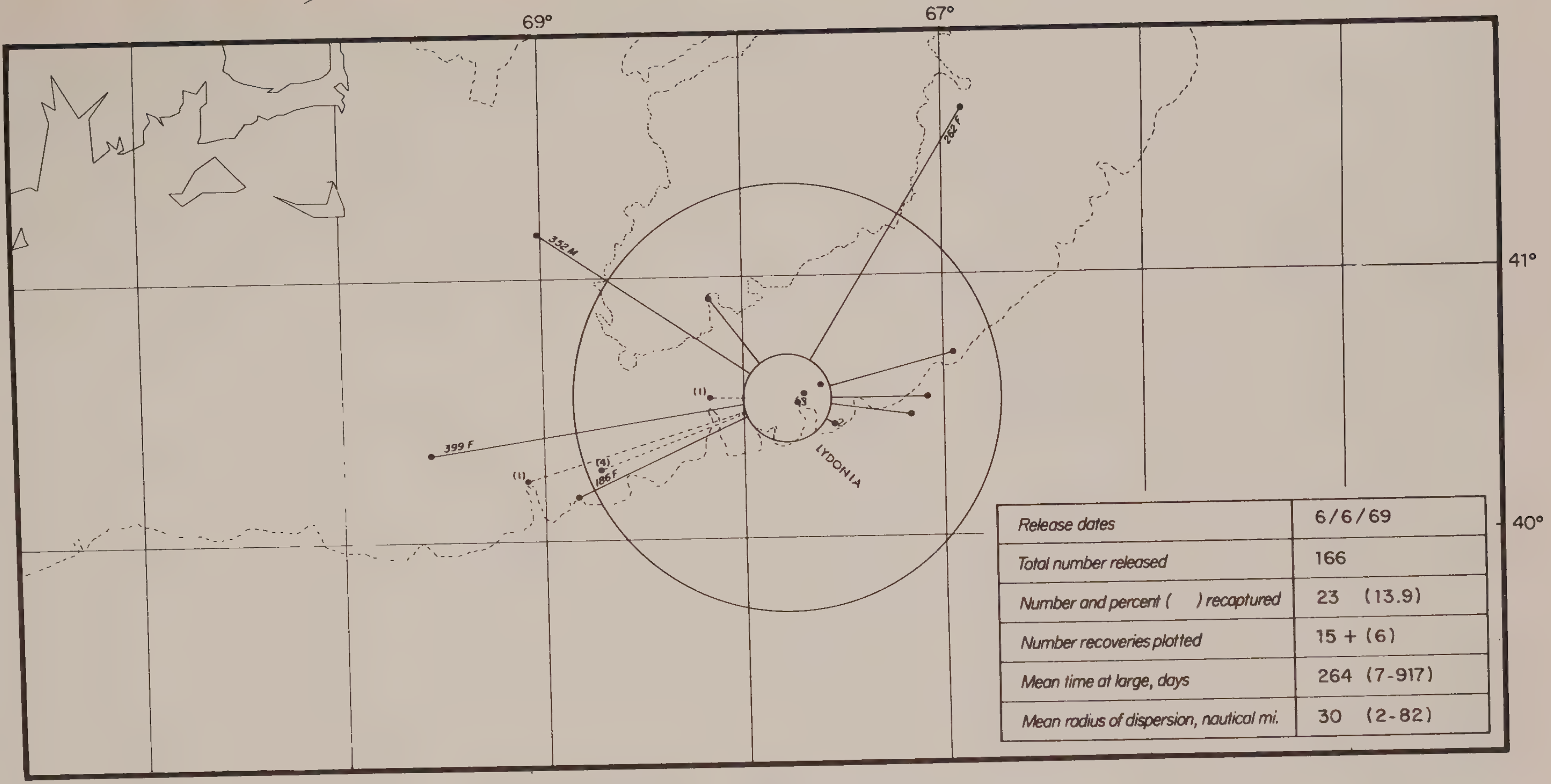
Release dates	4/30/69 5/1-2/69
Total number released	751
Number and percent ( ) recaptured	104 (13.8)
Number recoveries plotted	61 + (24)
Mean time at large, days	286 (15-842)
Mean radius of dispersion, nautical mi.	27 (5-125)

Figure 21.—Recoveries from composite station 19 plotted by 6-minute squares.


69°
67°
65°
42°
41°
40°
306F
315F
578F
697F
CORSAIR
(1)
2
3
3
3

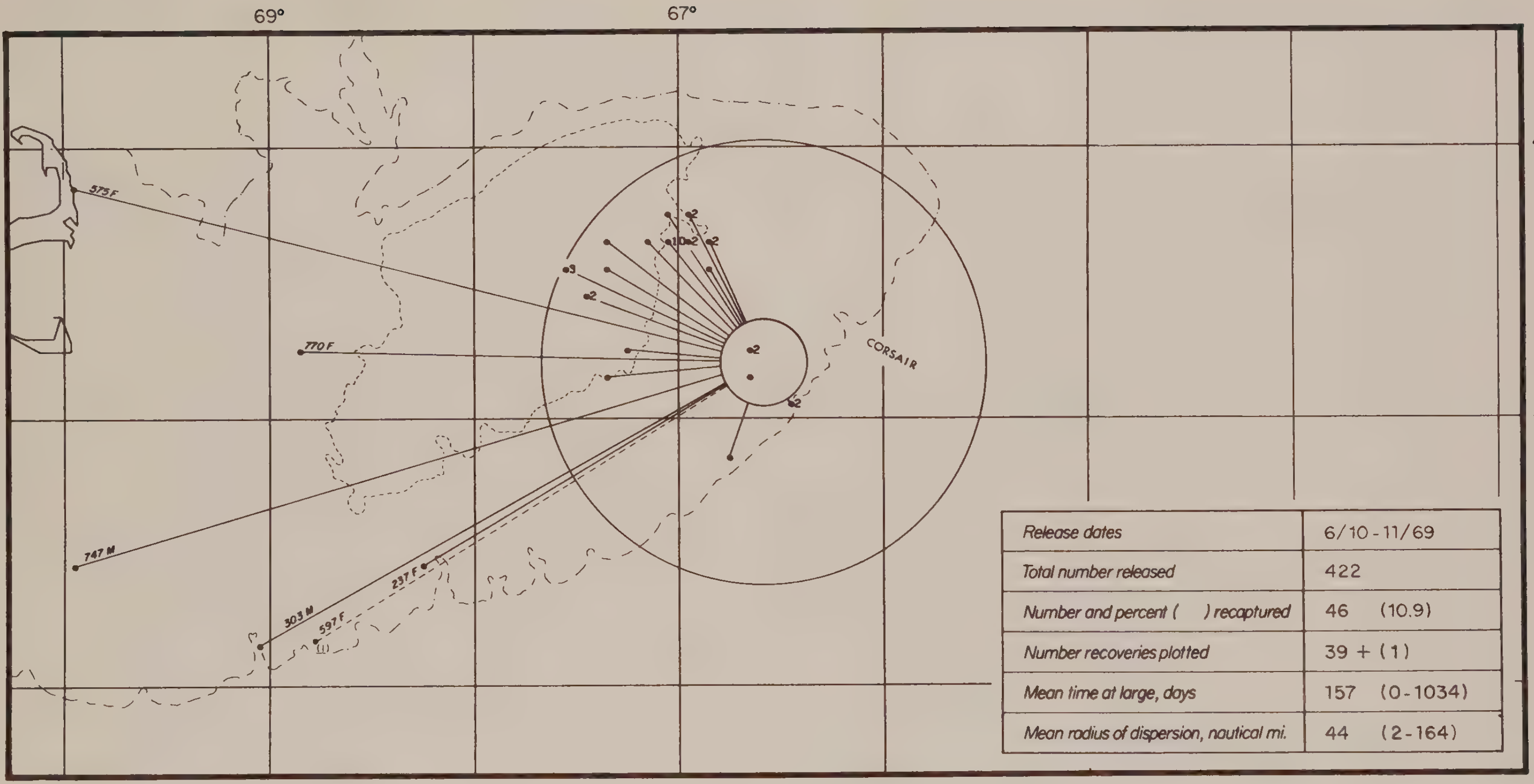
Release dates	5/7 - 9/69
Total number released	387
Number and percent ( ) recaptured	44 (11.4)
Number recoveries plotted	37 + (1)
Mean time at large, days	199 (12-1075)
Mean radius of dispersion, nautical mi.	30 (3-143)

Figure 22.—Recoveries from composite station 20.


69°
67°
41°
40°
352 M
262 F
399 F
186 F
(4)
(1)
(1)
3
2
LYDONIA

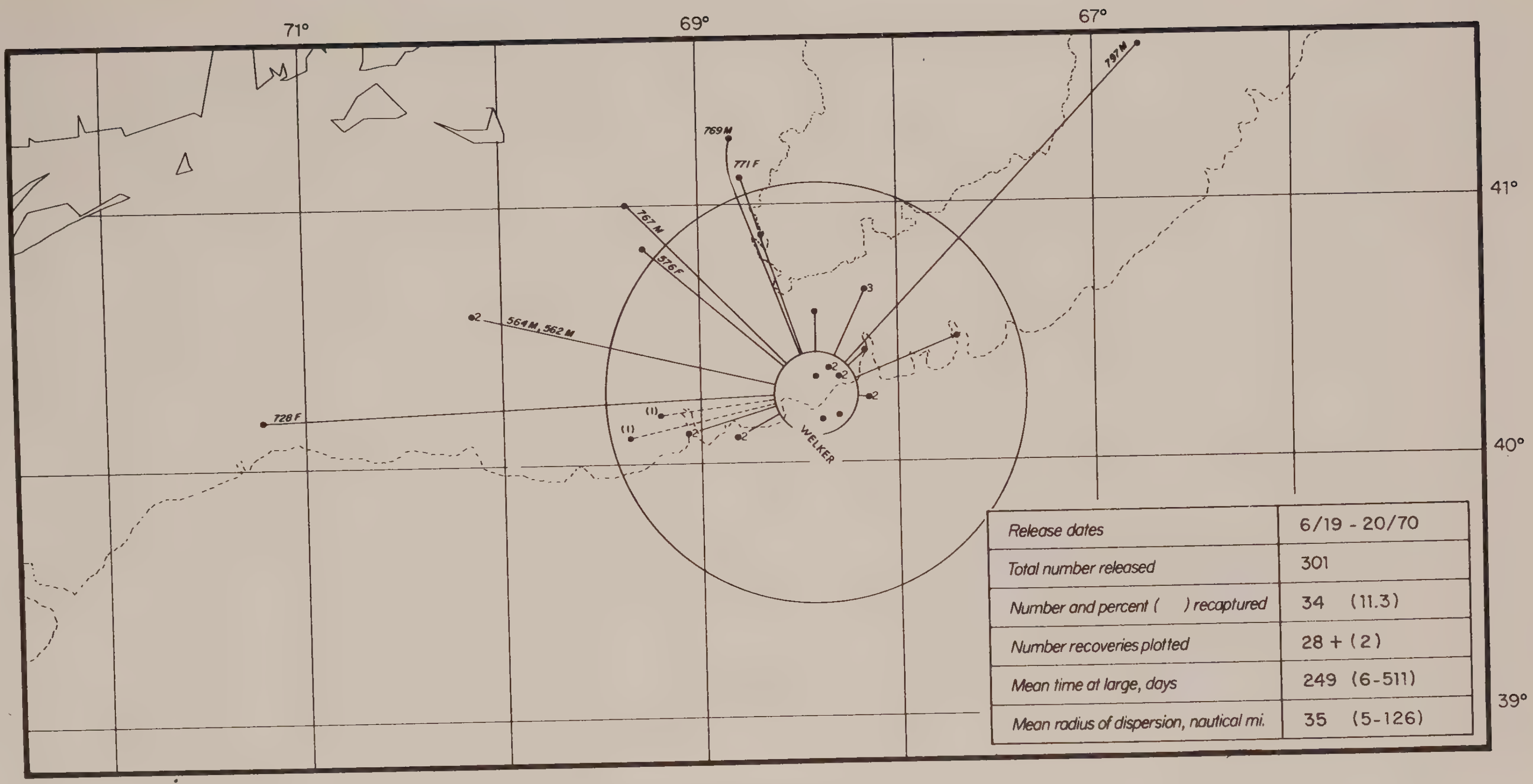
Release dates	6/6/69
Total number released	166
Number and percent ( ) recaptured	23 (13.9)
Number recoveries plotted	15 + (6)
Mean time at large, days	264 (7-917)
Mean radius of dispersion, nautical mi.	30 (2-82)

Figure 23.—Recoveries from composite station 21.


69°
67°
42°
41°
40°
575 F
770 F
747 M
303 M
597 F
(1)
237 F
3
2
10
CORSAIR

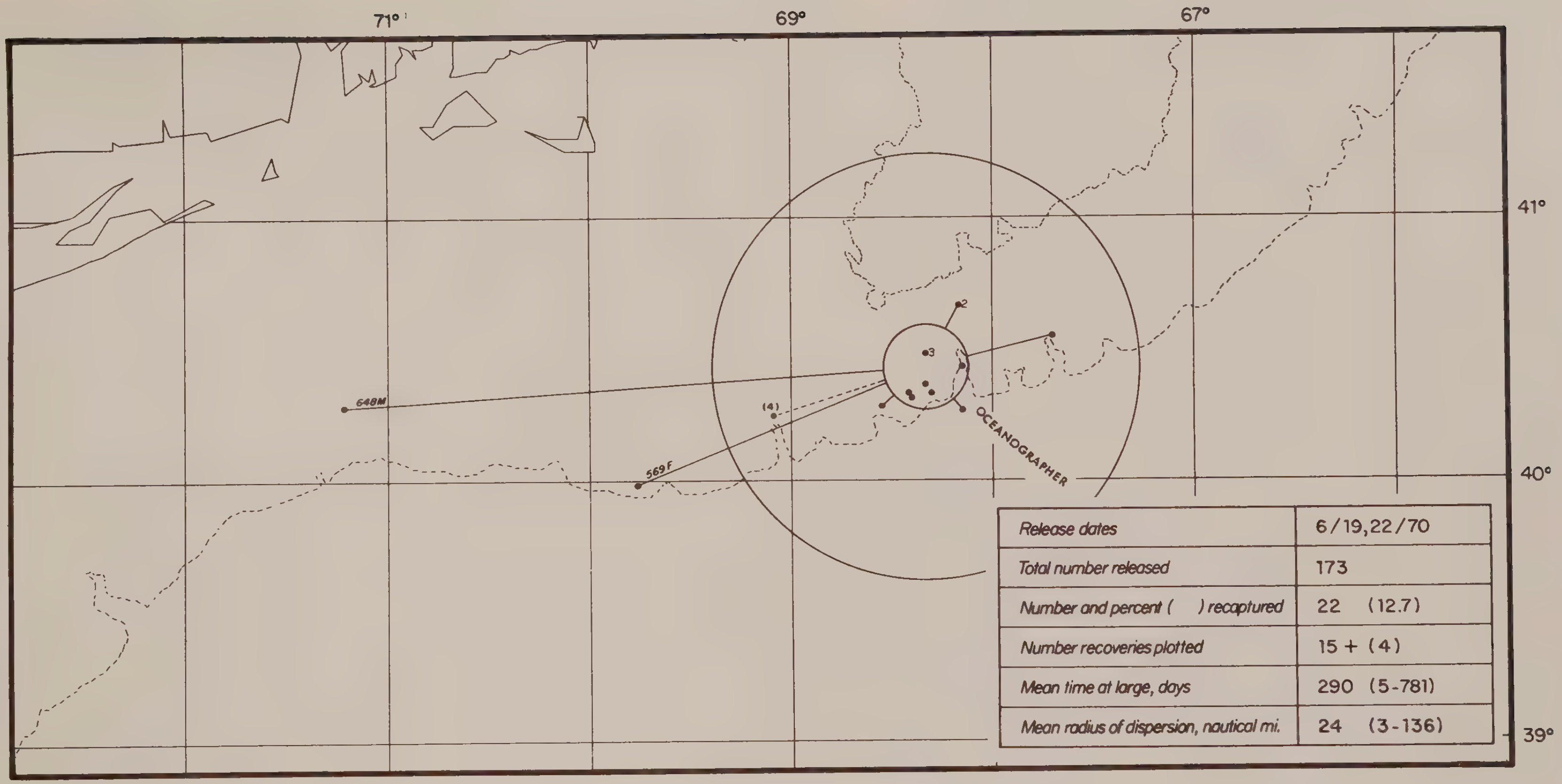
Release dates	6/10 - 11/69
Total number released	422
Number and percent ( ) recaptured	46 (10.9)
Number recoveries plotted	39 + (1)
Mean time at large, days	157 (0-1034)
Mean radius of dispersion, nautical mi.	44 (2-164)

Figure 24.—Recoveries from composite station 22 plotted by 6-minute squares.


71°
69°
67°
41°
40°
39°
797 M
769 M
771 F
767 M
576 F
564 M, 562 M
2
728 F
(1)
(1)
2
2
2
3
2
2
WELKER

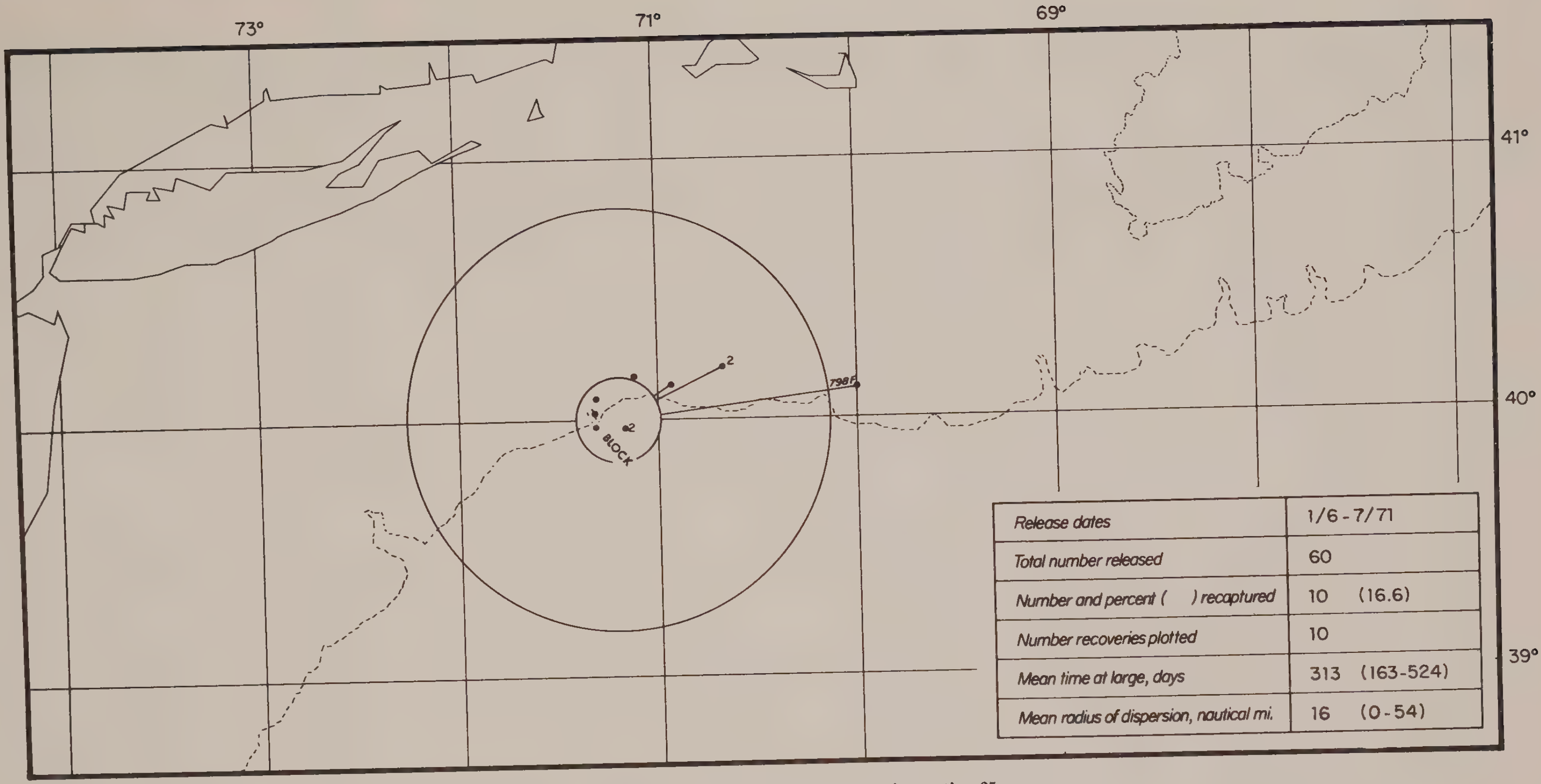
Release dates	6/19 - 20/70
Total number released	301
Number and percent ( ) recaptured	34 (11.3)
Number recoveries plotted	28 + (2)
Mean time at large, days	249 (6-511)
Mean radius of dispersion, nautical mi.	35 (5-126)

Figure 25.—Recoveries from composite station 23.


71°
69°
67°
41°
40°
39°
648M
569F
(4)
2
3
OCEANOGRAPHER

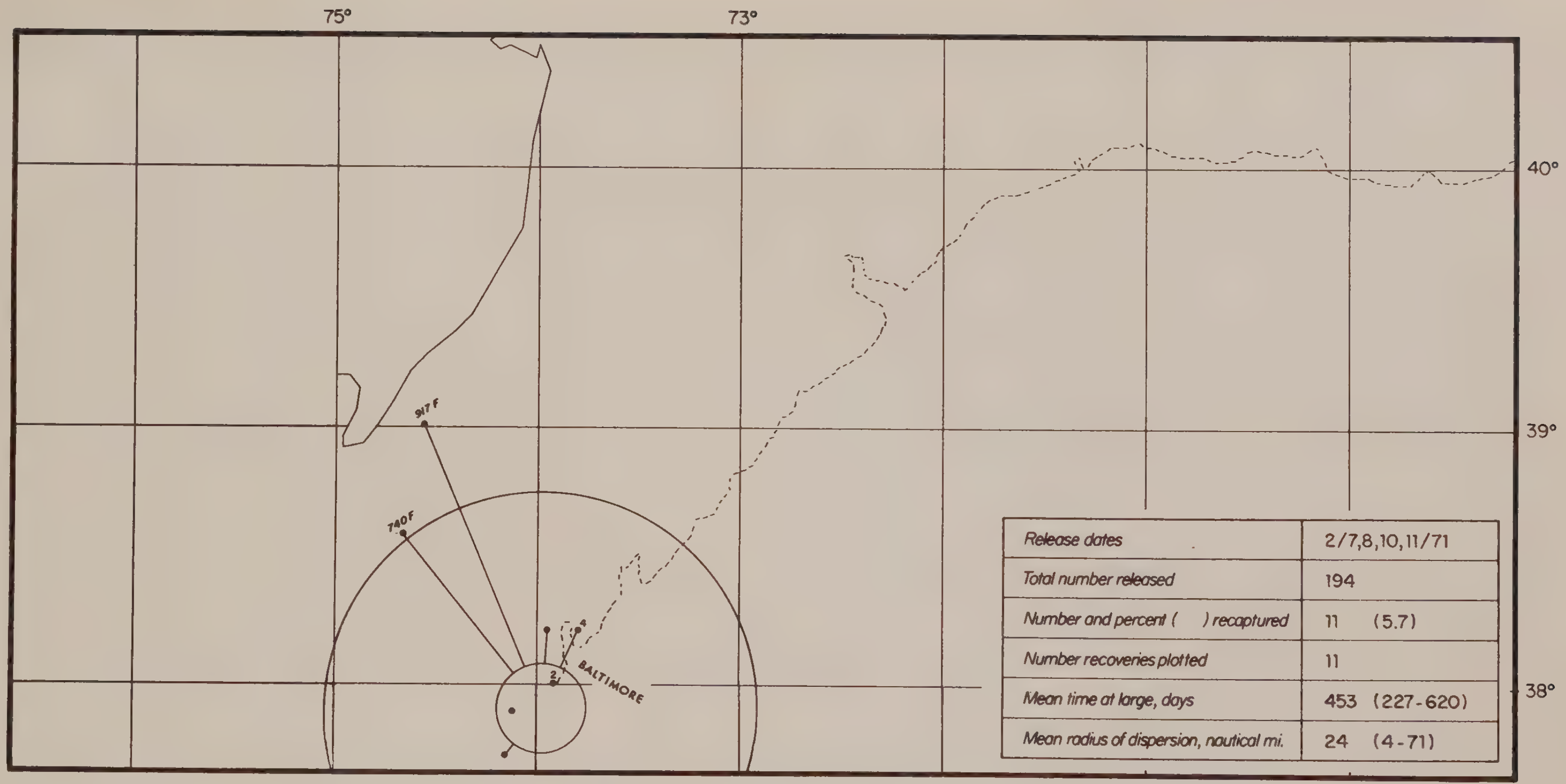
Release dates	6/19,22/70
Total number released	173
Number and percent ( ) recaptured	22 (12.7)
Number recoveries plotted	15 + (4)
Mean time at large, days	290 (5-781)
Mean radius of dispersion, nautical mi.	24 (3-136)

Figure 26.—Recoveries from composite station 24.


73°
71°
69°
41°
40°
39°
2
2
798F
BLOCK

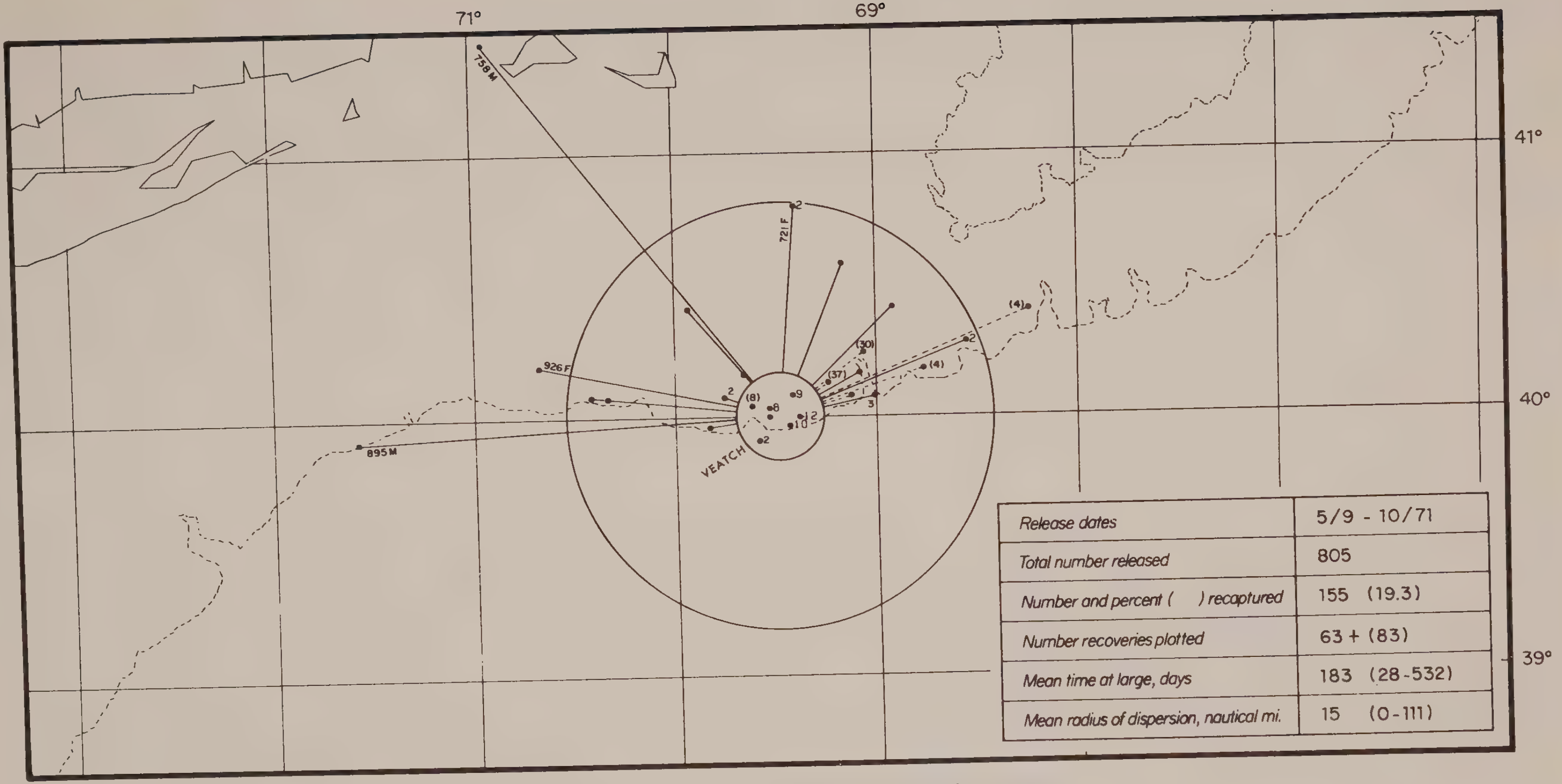
Release dates	1/6-7/71
Total number released	60
Number and percent ( ) recaptured	10 (16.6)
Number recoveries plotted	10
Mean time at large, days	313 (163-524)
Mean radius of dispersion, nautical mi.	16 (0-54)

Figure 27.—Recoveries from composite station 25.


75°
73°
40°
39°
38°
917 F
740F
4
2
BALTIMORE

Release dates	2/7,8,10,11/71
Total number released	194
Number and percent ( ) recaptured	11 (5.7)
Number recoveries plotted	11
Mean time at large, days	453 (227-620)
Mean radius of dispersion, nautical mi.	24 (4-71)

Figure 28.—Recoveries from composite station 27.


71°
69°
41°
40°
39°
758M
721F
926F
895M
VEATCH
(4)
2
(4)
(30)
(37)
3
2
(8)
9
8
2
10
2
2

Release dates	5/9 - 10/71
Total number released	805
Number and percent ( ) recaptured	155 (19.3)
Number recoveries plotted	63 + (83)
Mean time at large, days	183 (28-532)
Mean radius of dispersion, nautical mi.	15 (0-111)

Figure 29.—Recoveries from composite station 29 plotted by 6-minute squares.

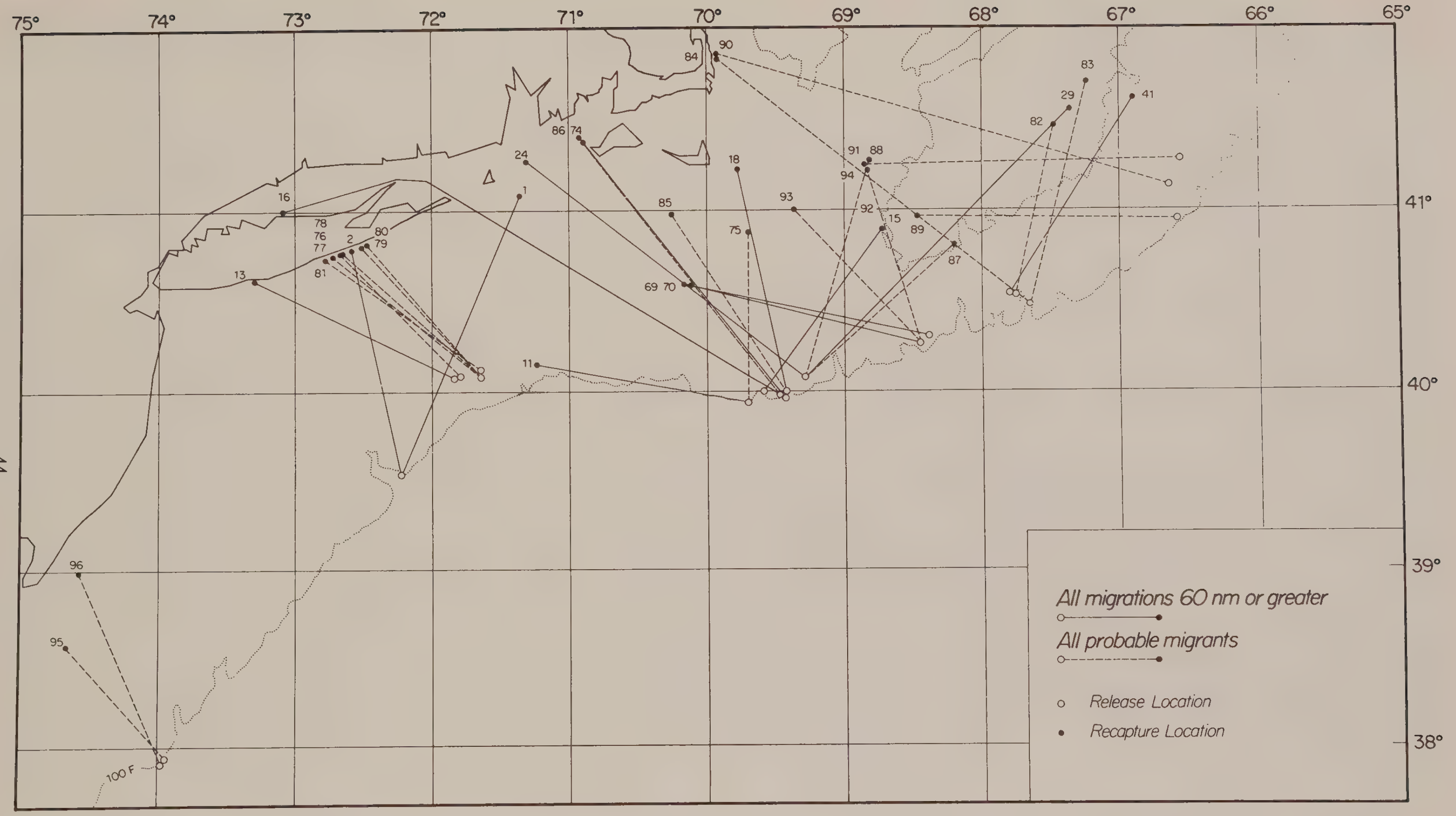

75°
74°
73°
72°
71°
70°
69°
68°
67°
66°
65°
41°
40°
39°
38°
90
84
83
29
41
82
86
74
91
88
94
24
18
1
16
85
93
92
15
89
78
76
2
80
77
79
81
75
87
13
69
70
11
96
95
100 F
All migrations 60 nm or greater
All probable migrants
Release Location
Recapture Location

Figure 30.--Shoalward migrations of 60 nautical miles (111 km) or greater and probable shoalward migrations of 50 nautical miles (92.7 km), Baltimore Canyon to Corsair Canyon.

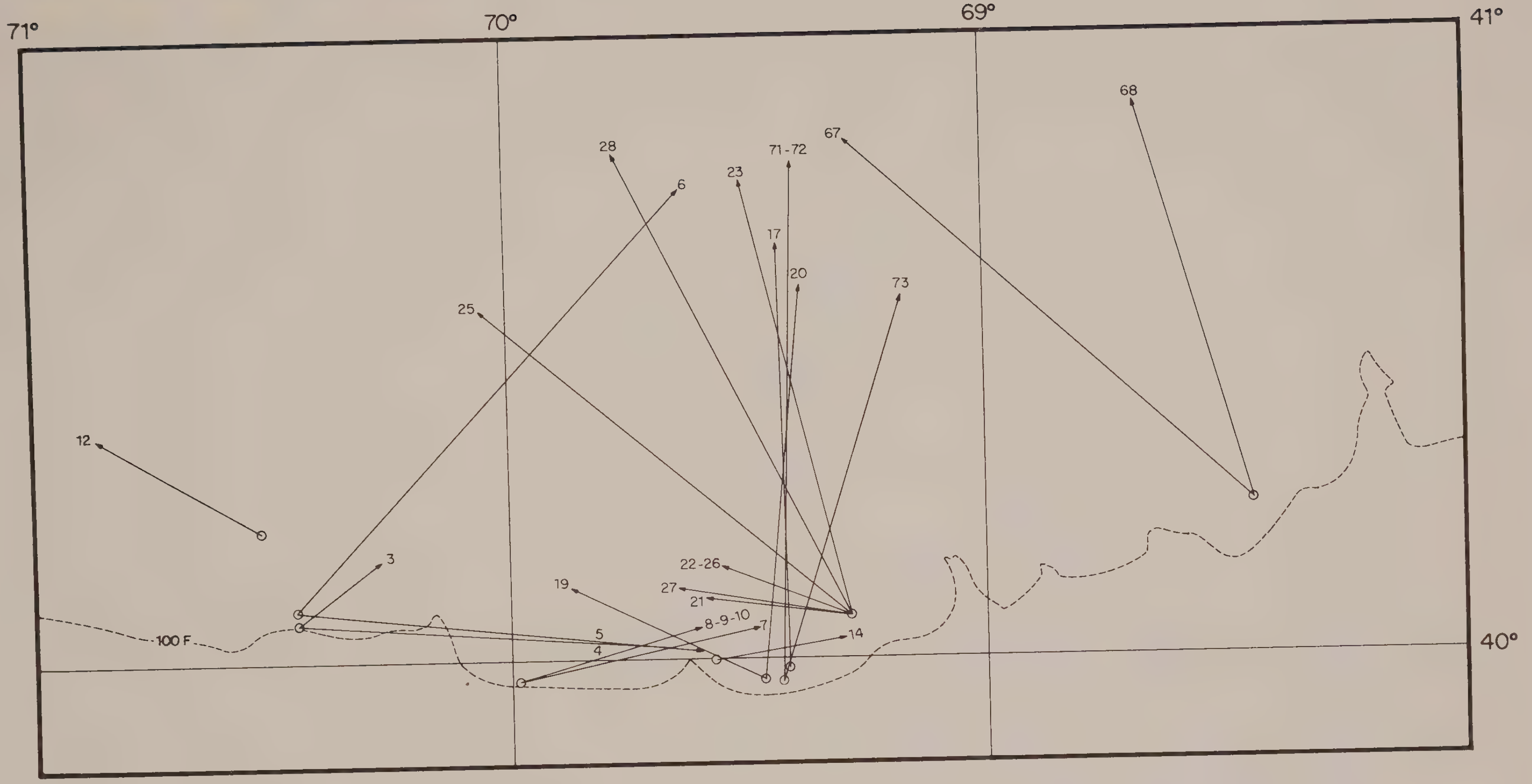
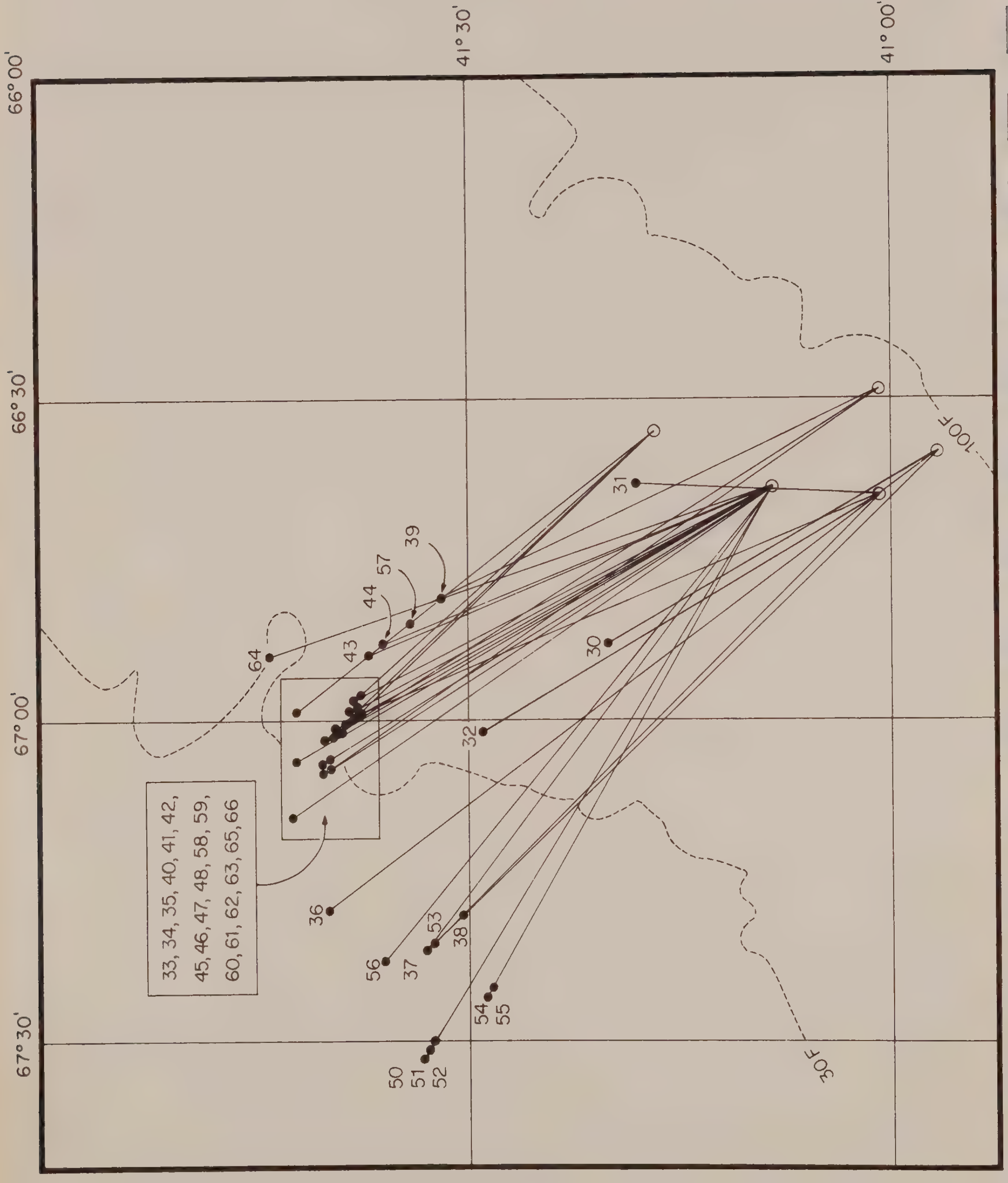

71°
70°
69°
41°
40°
68
67
28
71-72
23
6
17
20
73
25
12
3
19
22-26
27
21
8-9-10
7
5
4
14
100 F

Figure 31.—Shoalward migrations greater than 10 nautical miles (18.5 km) but less than 60 nautical miles (111 km), Block Canyon to Oceanographer Canyon.


66°00'
66°30'
67°00'
67°30'
41°30'
41°00'
100F
30F
30
31
32
36
37
38
39
43
44
50
51
52
53
54
55
56
57
64
33, 34, 35, 40, 41, 42,
45, 46, 47, 48, 58, 59,
60, 61, 62, 63, 65, 66

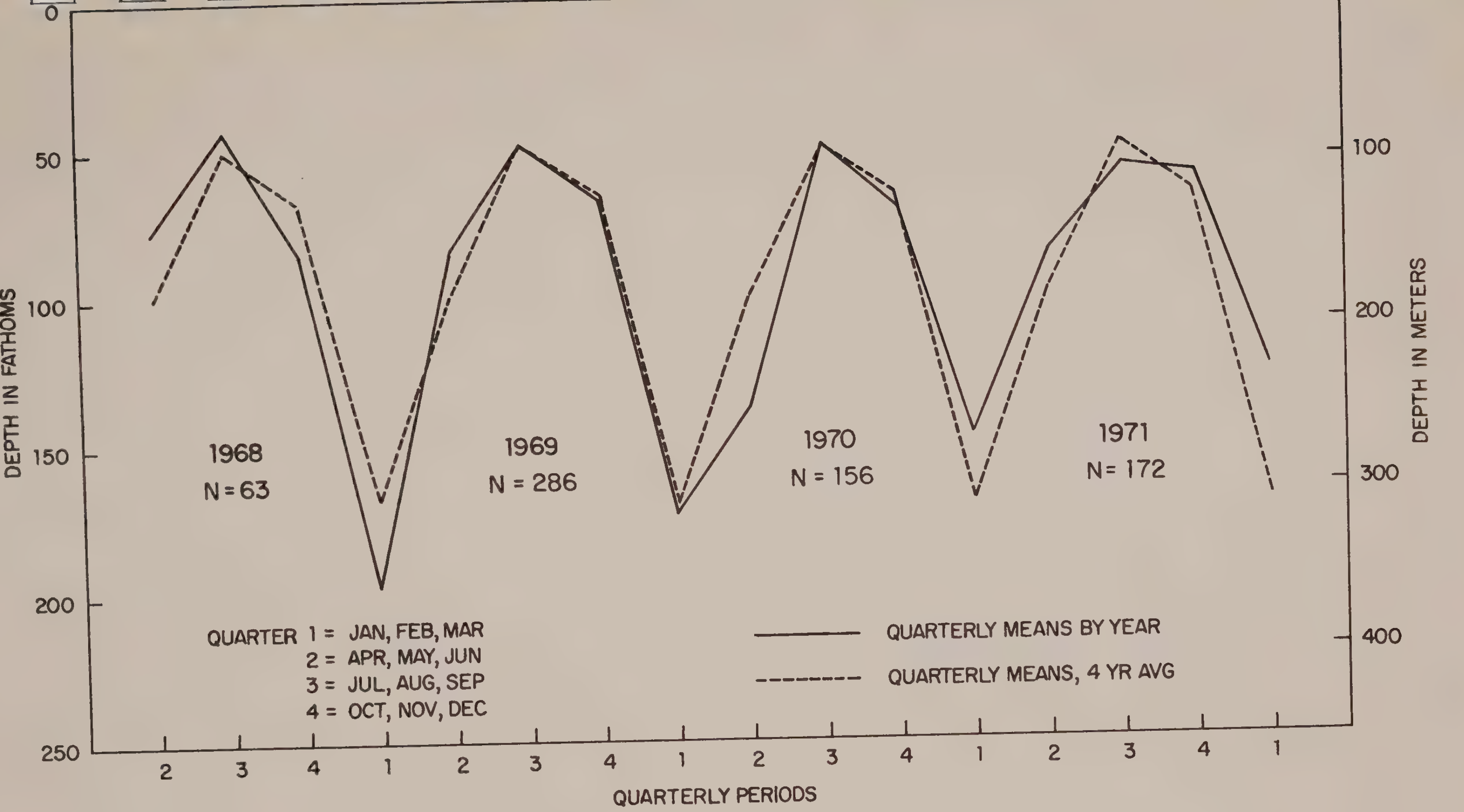


Figure 33.—Mean depth of recapture of tagged lobsters by quarterly periods, 1968-71.

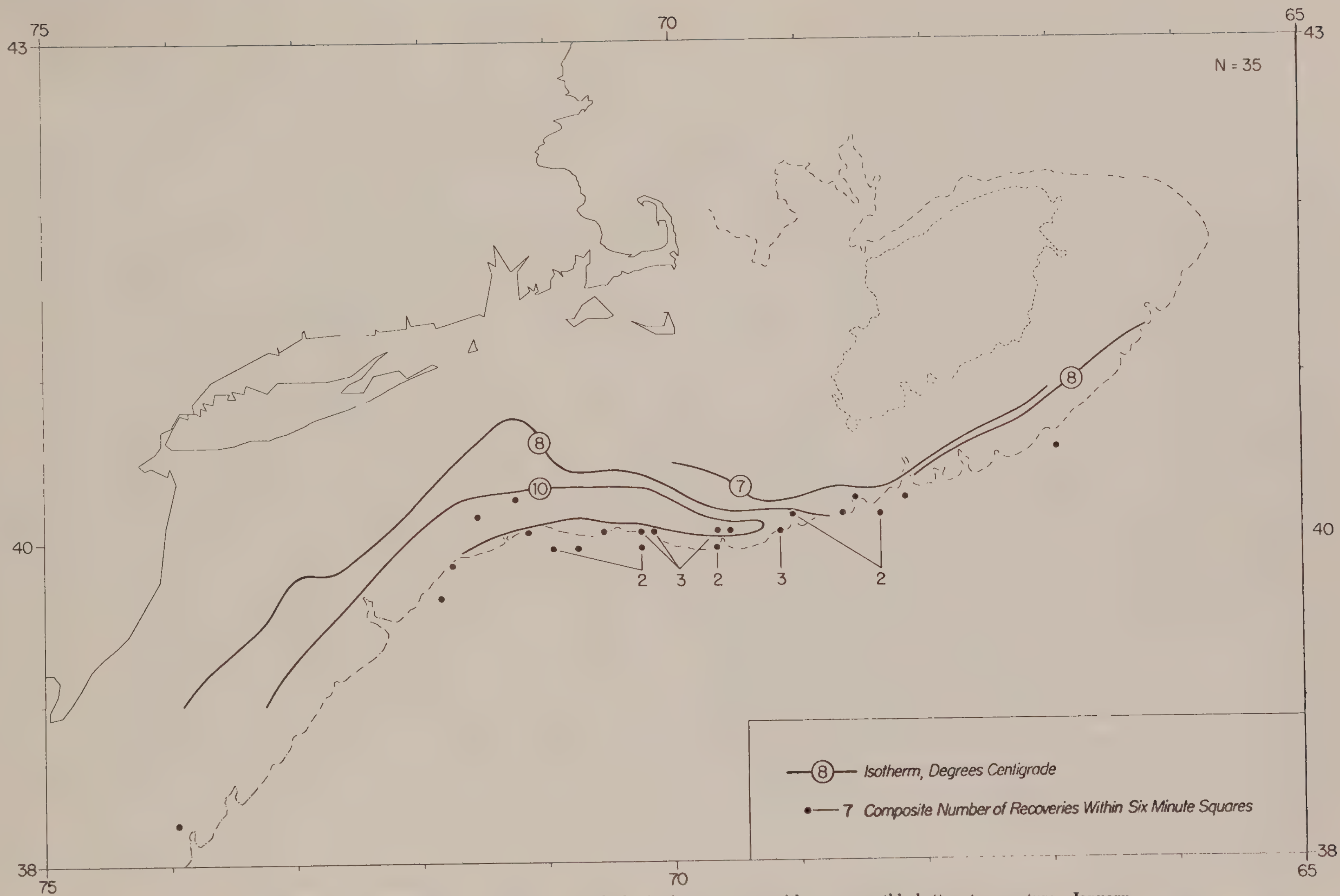

75
70
65
43
40
38
N = 35
8
7
10
2
3
2
3
2
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 34.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—January.

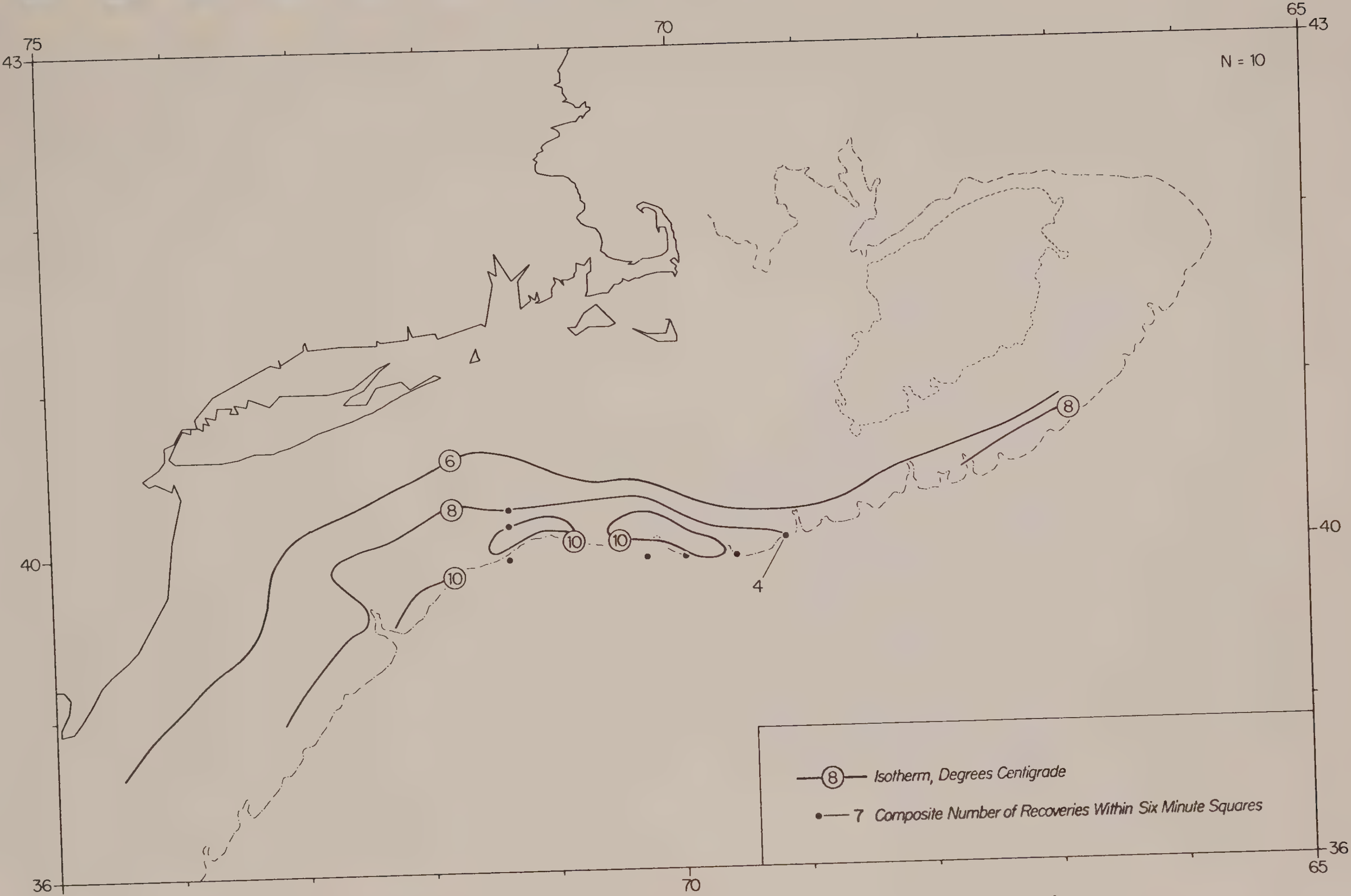

75
43
70
65
43
N = 10
6
8
10
10
10
8
4
40
40
36
75
70
36
65
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 35.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—February.

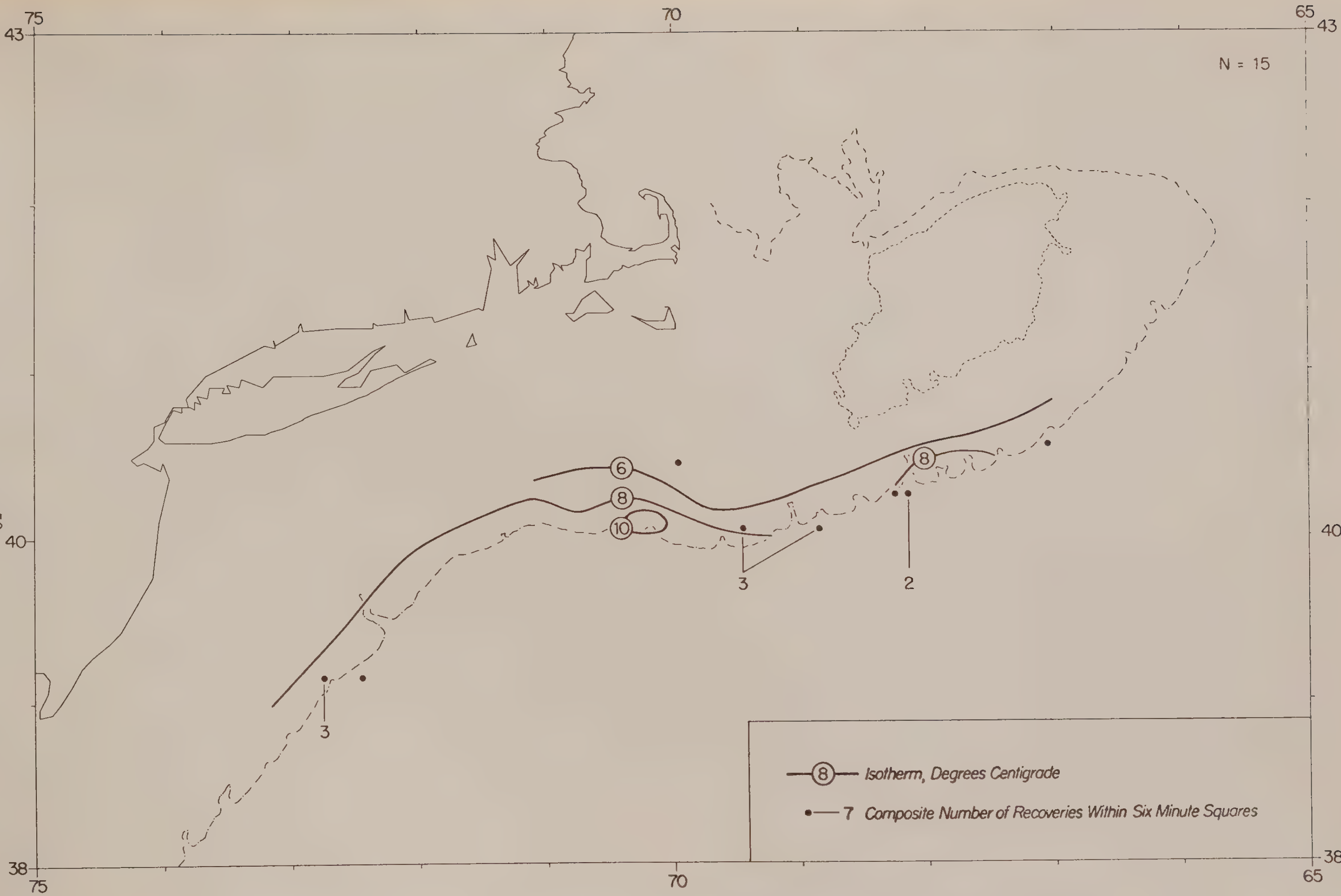

75
70
65
43
43
N = 15
40
40
38
38
75
70
65
6
8
10
8
3
2
3
8 Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 36.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—March.

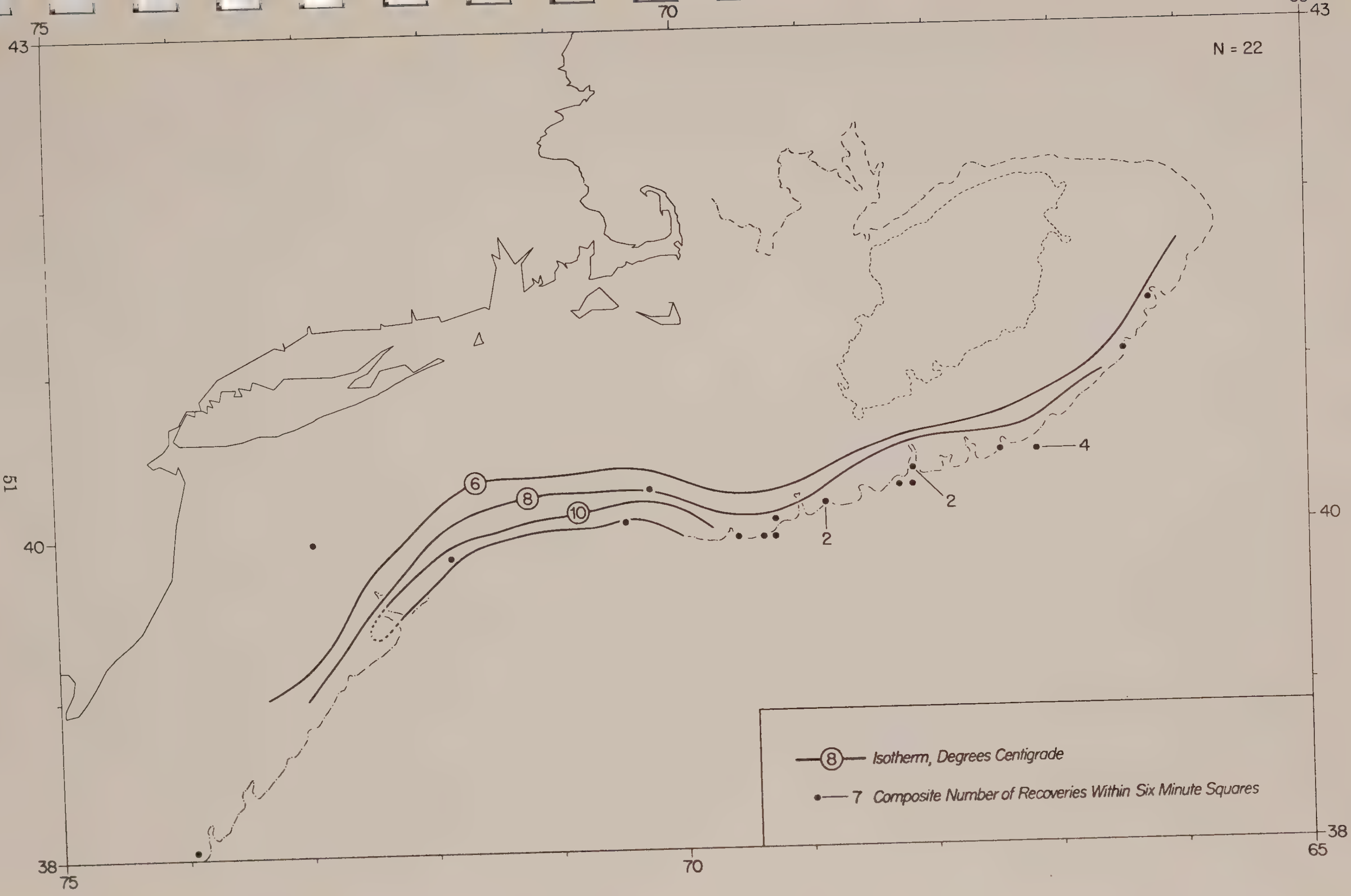

70
43
75
43
N = 22
6
8
10
4
2
2
40
40
38
65
38
75
70
⑧ Isotherm, Degrees Centigrade
• 7 Composite Number of Recoveries Within Six Minute Squares

Figure 37.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—April.

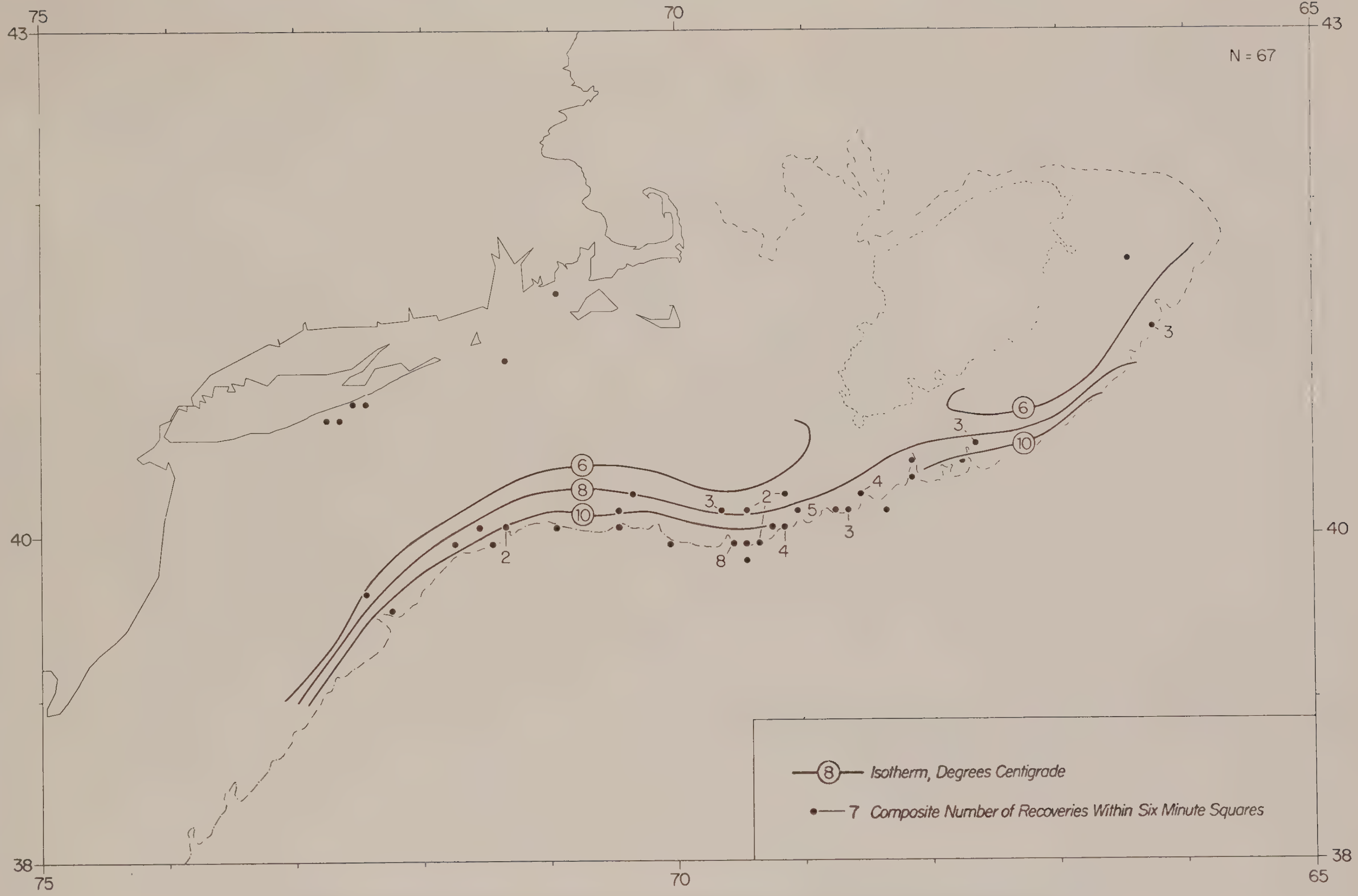

75
70
65
43
43
N = 67
6
8
10
6
10
3
3
2
3
4
5
3
4
8
2
3
4
40
40
38
38
75
70
65
8
Isotherm, Degrees Centigrade
7
Composite Number of Recoveries Within Six Minute Squares

Figure 38.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—May.

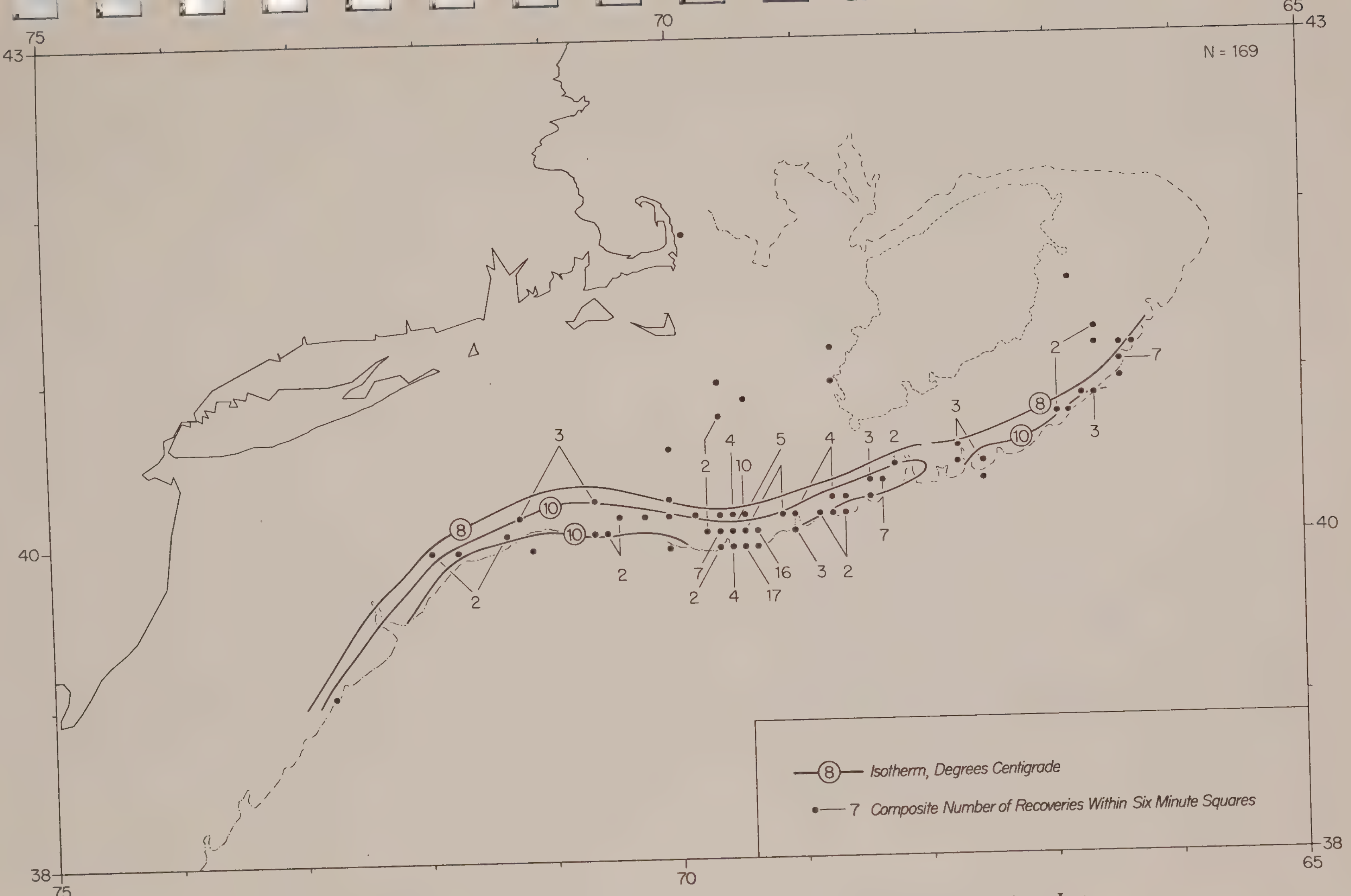

N = 169
75
70
65
43
40
38
8
10
2
3
4
5
7
16
17
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 39.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—June.

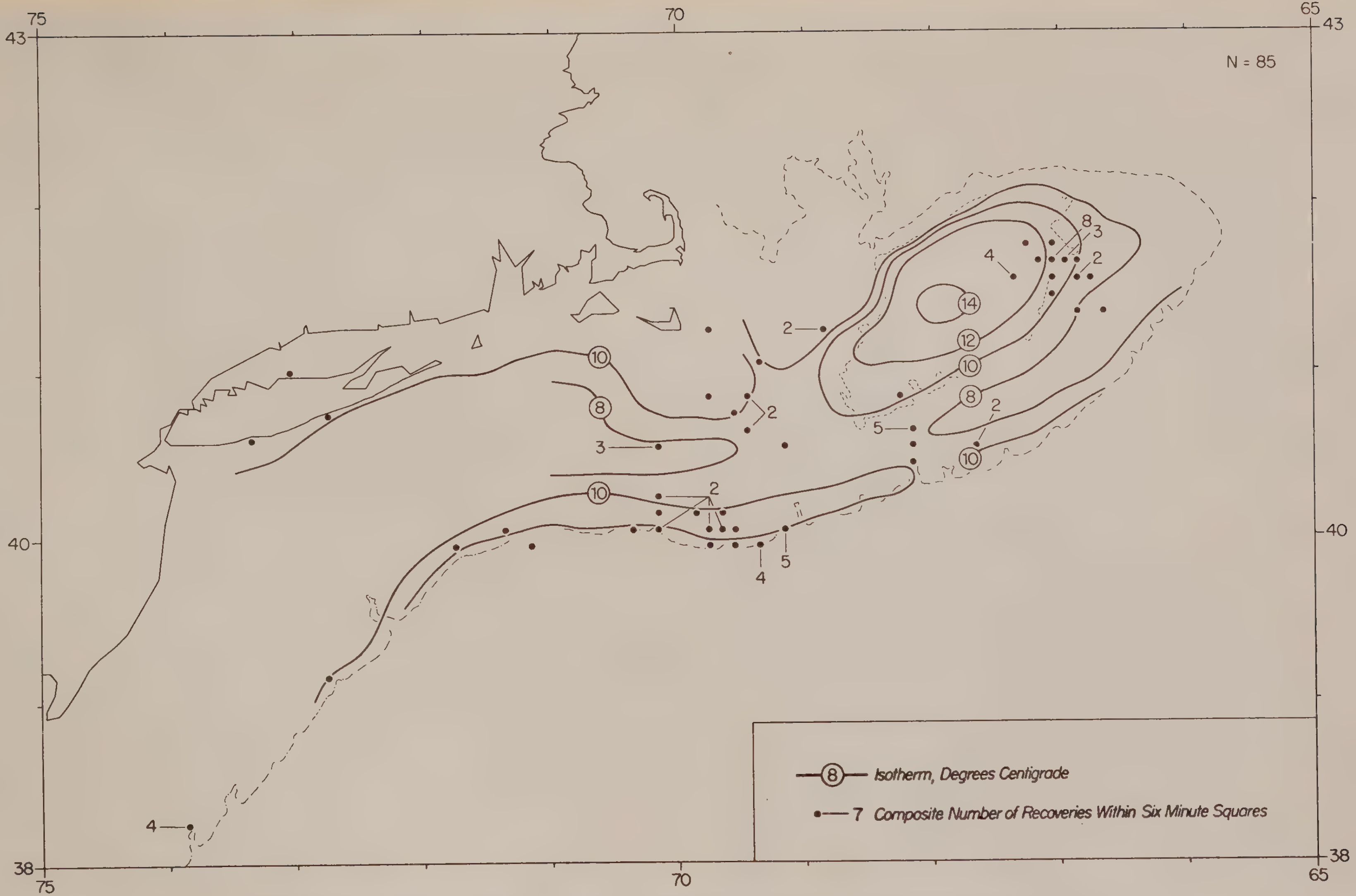

75
70
65
43
40
38
N = 85
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares
14
12
10
8
3
2
4
5

Figure 40.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—July.

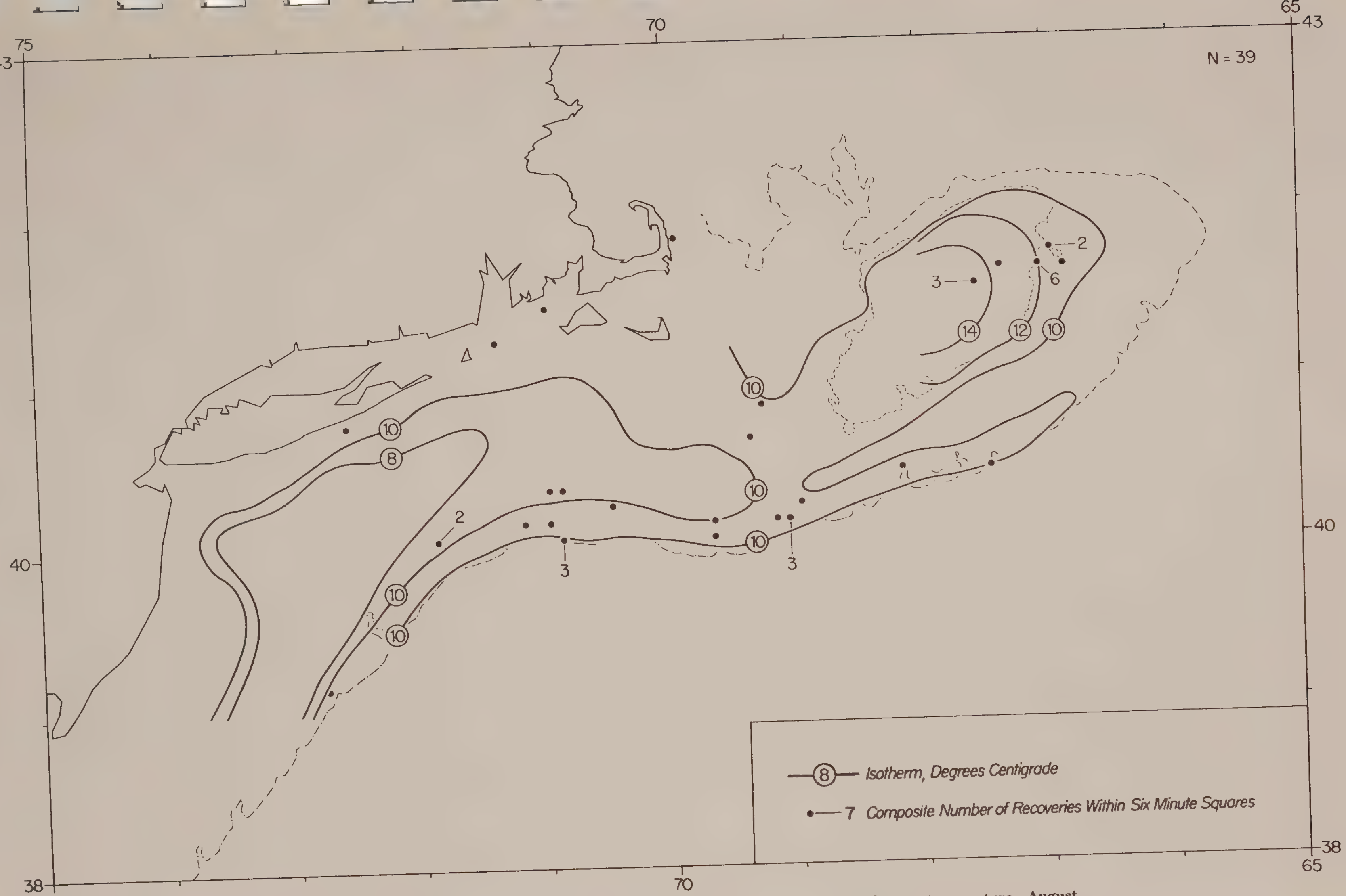

70
65
75
43
43
N = 39
2
6
3
14
12
10
10
10
8
10
2
3
10
3
10
10
40
40
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares
38
65
38
75
70

Figure 41.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—August.

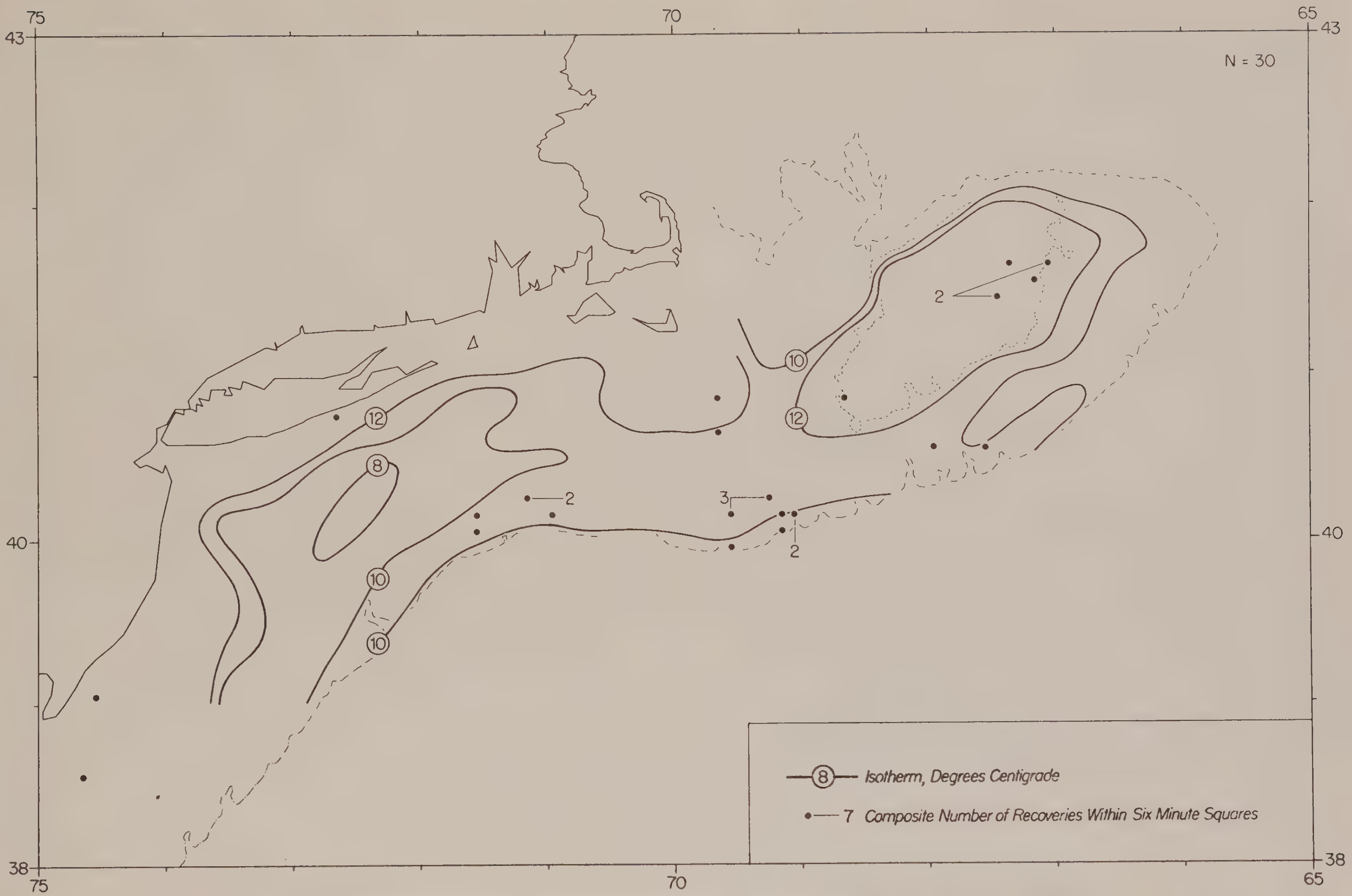

75
70
65
43
40
38
N = 30
2
12
10
8
3
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 42.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—September.

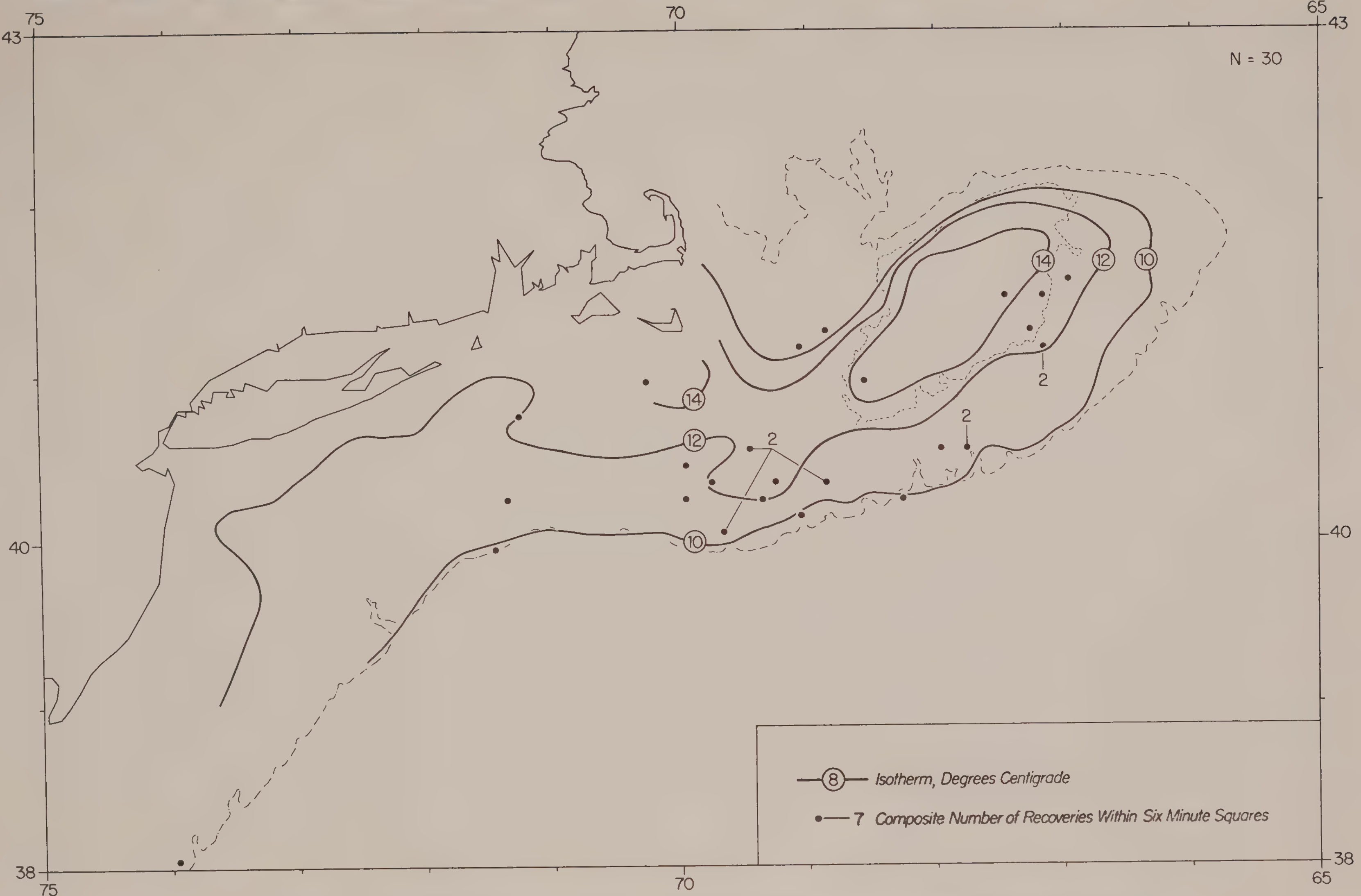

75
70
65
43
40
38
N = 30
14
12
10
2
2
2
2
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 43.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—October.

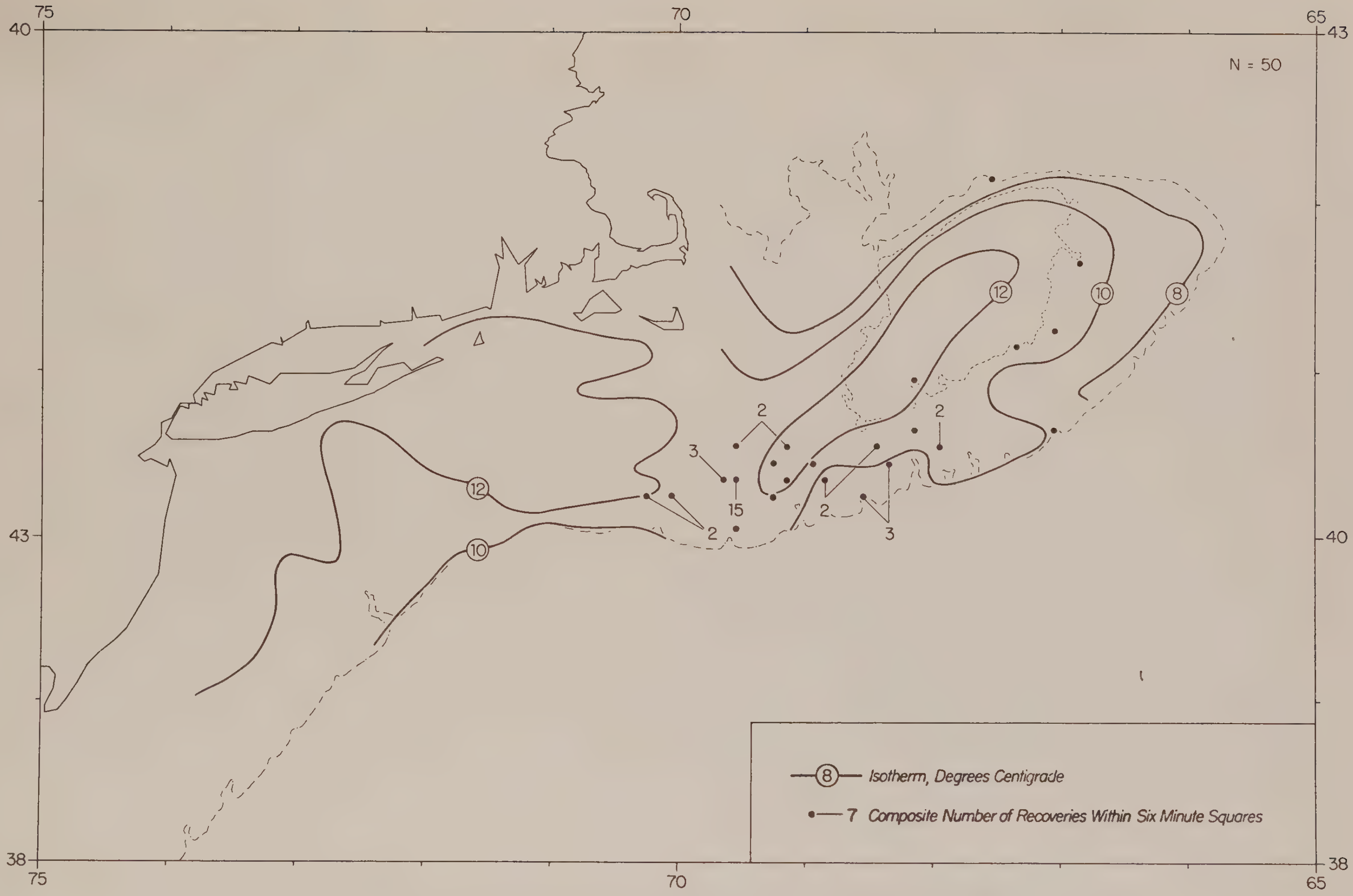

75
70
65
40
43
43
40
38
38
75
70
65
N = 50
8
10
12
12
10
2
2
3
15
2
2
3
2
Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 44.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—November.

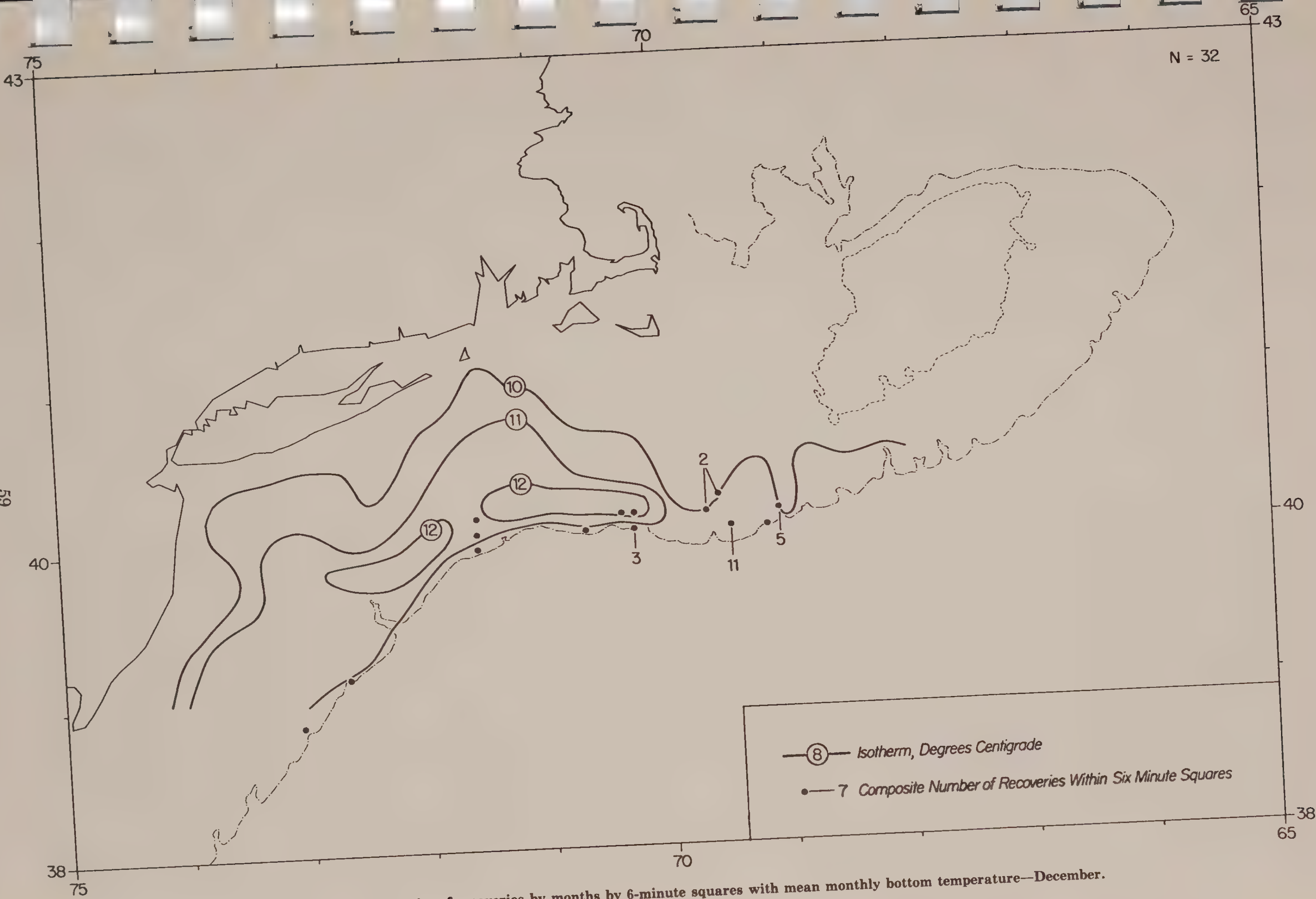

N = 32
75
43
70
65
43
40
40
38
75
70
65
38
10
11
12
12
2
5
11
3
8 Isotherm, Degrees Centigrade
7 Composite Number of Recoveries Within Six Minute Squares

Figure 45.—Composite of recoveries by months by 6-minute squares with mean monthly bottom temperature—December.

that of 758M followed by an equal, but nonreciprocal return leg leading back to the point of capture west of Block Canyon; we believe that this hypothetical kind of two-stage movement could account for many of the apparently directed easterly or westerly movements.

Only four of the recaptures qualify as migrants; all were recaptured in significantly shoaler water with three of the four effecting large-scale movements approximating 1 mile (1.85 km) per day while at large. Each of the tracks show optimal or near optimal directionality relative to the shoaling objective. Calculated bearing, ground speed, and depth change of these migrants are as follows:

		Ground speed		Depth change	
Return no.	Bearing	mi/day	km/day	fathoms	meters
721F	004°	1.0	1.9	+38	+70
738F	004°	0.9	1.7	+30	+55
779F	018°	0.5	0.9	+35	+64
758M	322°	1.0	1.9	+55	+101

SUMMARY OF DEFINED MOVEMENTS

It should be recalled that this report deals with 945 recaptured lobsters among which 584 (62%) of the total were reported by specific location and hence classifiable according to the scheme outlined in the section on migration versus dispersion. According to the criteria laid down, 117 recaptures have been defined as migrants, 15 as nonmigrants, 147 as residual nonmigrants, and 297 as indeterminates, thus yielding a total of 576 defined movements. The discrepancy between the total of 584 located recaptures and 576 defined movements is due to the fact that eight of the located recaptures were reported without a date of recapture and hence could not be classified.

Among the 117 defined migrants, 74 (63%) effected net shoalward movements of 10 fathoms (18.3 m) or more beyond the release point (Table 2). Although these tracks have been depicted in preceding figures as elements of the overall recovery patterns of their respective release group, it is instructive to isolate them from their original cohorts and examine them collectively. The intent of Figures 30-32 is to show more clearly the variability of performance of the migrants which conform with our hypothesis of vernal shoalward migration while eliminating the confounding effects of other kinds of movements.

The ratio of these conforming (shoaling) migrants to the sum total of defined movements is 74:576. This grouping permits the inference from these tag returns that some 13% of the population at large annually engages in seasonal shoalward migration to a greater or lesser degree.

It is important to note that 297 of the 576 classified movements fall in the indeterminate category. This group constitutes 51% of the classified movements and includes a significant number of dispersions which, while failing to meet the migrant criteria because of the 120-day time constraint, may be subjectively interpreted as migrants on the basis of relative dislocation from t continental margin and month of recapture.

In order to give fuller consideration to the movements, and to assess their additive effect on t previously derived estimate of 13% participation in a nual shoalward migration, we have selected and redef ed as probable migrants those indeterminates wh recapture locations were at least 50 miles (92.7 km) fr original release locality and at least 50 miles (92.7 k from the nearest margin of the continental shelf. Th highly restrictive criteria admit only 22 additional e tries (Table 2) to the asserted list of conforming (sho ing) migrants and raises the theoretical ratio shoalward migrations to 17%. We have assumed that t shoalward excursions of these probable migrants co menced in springtime from the shelf margin in the vici ty of first capture or, alternatively, from some other poi on the shelf margin no less than 50 miles (92.7 km) fr point of recapture. These restrictions effectively exclu a considerable number of other indeterminates of or slightly lesser performance. If we assume that 13% of t indeterminates, or 39 lobsters, demonstrated ver shoaling, as was the estimate from the defined migran the revised estimate of shoalward migration would 20% (74 + 39 = 113, or 20% of 576). We can conclu from this review and reassessment of movements that least 17-20% of the tagged population engaged seasonally directed shoalward migration, that some 2 remained more or less localized (nonmigrants), and th the balance of classified movements (indeterminat might, by more definitive criteria, be assignable to one the other of the first two categories. We believe that t 17-20% estimate of shoalward migration is highly cons vative. The major impediment to correct allocation the movements observed is our unsatisfactory knowled of 1) homing tendencies and 2) the realistic limits on t radius of dispersion of localized movements in any giv year. Until these issues are resolved by further e perimentation (sonic tagging with periodic tracking), have no basis for classification other than the partly bitrary system we have used. We believe, neverthele that the deductive process used is substantially valid a provides an acceptable interpretation of the seaso movements of lobsters comprising the offshore stock. T following sections on the monthly distribution of reca tures in relation to depth and temperature further su stantiates the arguments advanced heretofore.

DEPTH DISTRIBUTION AT RECAPTURE

Analysis of the depth distribution of recaptu lobsters by month of capture shows a pronoun cyclical pattern of shoaling during the shelf warmi period followed by retreat to the shelf margin and sl in winter months. These trends are summarized Figure 33 which shows mean depth at recapture quarterly periods over the 4-yr period 1968-72.

Inspection of third quarter (July, August, Septemb averages shows relatively little deviation from the 4 mean of 50 fathoms (91.4 m); similarly, fourth quar ble 2.—Recapture data for 74 shoalward migrating lobsters demonstrating shoaling of 10 fathoms (18.3 m) or more and 22 probable migrants recapture location was at least 50 nautical miles (92.7 km) from release and at least 50 miles from nearest margin of continental shelf.

Figures 30-32 r no.	Return no. and composite station no.	Nautical miles	Days at large	Average speed (mi/day)	Depth change (fathoms)	Figures 30-32 vector no.	Return no. and composite station no.	Nautical miles	Days at large	Average speed (mi/day)	Depth change (fathoms)
1	3F-3	102	29	3.5	60	49	293F-22	38	60	0.6	14
2	29F-3	77	118	0.6	75	50	307F-22	48	72	0.7	22
3	4F-5	11	36	0.3	34	51	308F-22	48	72	0.7	22
4	26F-5	38	37	1.0	18	52	309F-22	48	72	0.7	22
5	27F-5	38	37	1.0	20	53	316F-22	41	48	0.9	25
6	28F-5	56	50	1.1	78	54	336F-22	42	89	0.5	25
7	10F-6	24	33	0.7	42	55	337F-22	42	89	0.5	25
8	18F-6	18	49	0.4	29	56	339F-22	44	86	0.5	20
9	19F-6	18	49	0.4	29	57	222M-22	22	23	0.9	14
10	20M-6	18	49	0.4	29	58	242M-22	35	25	1.4	12
11	8M-7	72	39	1.8	37	59	243M-22	40	28	1.4	20
12	41F-10	20	60	0.3	10	60	248M-22	41	31	1.3	24
13	25F-13	75	28	2.7	38	61	258M-22	32	37	0.9	23
14	221F-18	12	54	0.2	10	62	261M-22	35	41	0.8	19
15	240F-18	66	32	2.1	36	63	278M-22	30	45	0.7	18
16	249F-18	186	71	2.6	68	64	310M-22	38	67	0.6	20
17	254F-18	41	71	0.6	42	65	341M-22	32	89	0.3	18
18	263F-18	76	80	0.9	50	66	342M-22	32	89	0.3	18
19	266M-18	21	85	0.2	15	67	576F-23	52	48	1.1	59
20	311M-18	39	106	0.4	45	68	584F-23	39	84	0.5	51
21	184F-19	15	40	0.4	10	69	562M-23	80	16	5.0	52
22	191F-19	14	43	0.3	15	70	564M-23	83	15	5.5	50
23	255F-19	45	70	0.6	45	71	721F-29	50	49	1.0	38
24	294F-19	118	107	1.1	47	72	738F-29	50	53	0.9	30
25	654F-19	47	41	1.1	32	73	779F-29	39	79	0.5	35
26	190M-19	14	43	0.3	15	74	758M-29	111	108	1.0	55
27	194M-19	17	42	0.4	10	75	544F-7	58	771		
28	246M-19	51	67	0.8	48	76	335F-13	56	465		
29	317M-19	125	86	1.4	38	77	347F-14	65	365		
30	244F-20	27	60	0.4	16	78	348F-14	62	365		
31	247F-20	18	62	0.3	11	79	349F-14	59	365		
32	252F-20	32	66	0.5	16	80	350F-14	59	365		
33	259F-20	47	70	0.7	23	81	269M-14	65	392		
34	276F-20	41	79	0.5	18	82	357F-17	58	353		
35	277F-20	41	79	0.5	18	83	768F-17	76	1,010		
36	306F-20	54	100	0.5	22	84	937M-17	132	973		
37	314F-20	45	81	0.5	23	85	355F-18	70	166		
38	315F-20	50	82	0.6	23	86	720M-18	110	761		
39	200M-20	35	43	0.8	13	87	610F-19	66	443		
40	285M-20	48	94	0.5	20	88	577M-19	78	522		
41	262F-21	76	44	1.7	24	89	578F-20	87	519		
42	236F-22	33	20	1.6	17	90	575F-22	155	431		
43	238F-22	32	21	1.5	18	91	770F-22	103	750		
44	251F-22	32	32	1.0	18	92	767M-23	62	389		
45	260F-22	37	38	1.0	25	93	769M-23	60	377		
46	284F-22	32	60	0.5	17	94	771F-23	54	361		
47	287F-22	38	59	0.6	21	95	740F-27	52	227		
48	288F-22	38	59	0.6	22	96	917F-27	71	230		

ages are in good agreement with the 4-yr mean of 66 thoms (121 m). In contrast, the first quarter averages an almost straight-line cline ranging from 197 ms (360 m) in 1969 to 127 fathoms (232 m) in 1972; implication of this trend is not clear because of the atively small numbers and large range of observations which these means were derived. If, however, the is real, it suggests that slope waters became ogressively warmer over the 4-yr period to the degree at optimal overwintering conditions (discussed below r Average Monthly Bottom Temperatures) were met ogressively shoaler levels. The sum of deviations of cond quarter means from the 4-yr averages are almost as great as those of the first quarter; here, however, the major source of deviation stems from a disproportionate number of deep-running recaptures taken in April 1970.

Despite the shortcomings of the data, the clearly cyclical nature of seasonal depth change seems, independent of net track analyses, adequate evidence of the tendency of offshore lobsters to optimize their year-round temperature regime. The consequences of this behavior are manifold in that metabolic rates and related life processes are doubtless accelerated relative to the coastal zone populations which tend to remain highly localized and hence subject to wider seasonal extremes and significantly lower mean annual temperature.

AVERAGE MONTHLY BOTTOM TEMPERATURES

The distribution of recaptured tagged lobsters by month and grouped by 6-minute squares against average bottom water temperatures (°C) from Colton and Stoddard (1973) are presented in Figures 34-45. Bottom isotherms are plotted from data collected during the period 1940-66. Only recaptures whose month and location of recapture are known ($N = 584$) are plotted.

Relating lobster distribution to average bottom water temperatures, it is apparent that the offshore lobster population generally maintains itself within a temperature regime of 8°-14°C. The two apparent exceptions to this generalization, evident in Figures 36 (March) and 37 (April), are predictable. Bottom isotherms represent average temperature conditions for a 26-yr period, and the temperature conditions for a given month vary considerably from year to year and within a given month (Colton and Stoddard 1973; and Chamberlin[2]).

During the first quarterly period, January through March, offshore lobsters are distributed along the outer continental shelf and upper slope (Figs. 34-36). Bottom water temperatures during this period ranged from 8° to 12°C (Colton and Stoddard 1973; Chamberlin[2]). In contrast, the inshore, shallow-water lobster populations are in a state of reduced activity in coastal waters of 0°-4°C (Cooper et al. 1975).

During the second quarterly period, April through June, the onset of shoalward migration has begun, occurring first (April and May) in the western half of the shelf (Figs. 37, 38) and next (June) in the eastern half of the shelf (Fig. 39). Bottom water temperatures in the latter half of May along southern Long Island, Block Island Sound, and Buzzards Bay are 8°C and warmer (Colton and Stoddard 1973). An intensive fishery for lobsters occurs along southern Long Island from late May through mid-July, directed primarily toward the onshore migrants emanating from Hudson to Veatch Canyon (Cooper and Uzmann, unpubl. studies). Lobster migrations into the southern Long Island coastal waters are evident from Figures 6, 15, and 16.

Figures 40-43 (July-October) demonstrate that the offshore lobster population is widely distributed over the southern New England continental shelf, including the shoal waters of Georges Bank and the coastal waters of Long Island, Rhode Island, southern Massachusetts, and Cape Cod. Bottom water temperatures in areas of apparent lobster abundance during July-September are 8°-14°C.

The return migration to the outer shelf-upper slope waters probably begins in August (Fig. 41) and continues through September, October, and November (Figs. 42-44). Migration to deep water first occurs in the west half of the shelf and then in the eastern half.

During the first month (October) of the last qua (October-December) there are still some lobsters c tributed over the shoals of Georges Bank and immedia ly south of Nantucket Island (Fig. 43) with bottom w temperatures of 10°-14°C. By December the offsh lobster population is again distributed along the ou continental shelf and upper slope waters (Fig. 45) wh bottom temperatures are 8°-12°C.

CONCLUSIONS

The distribution of tag returns from a 4-yr tagging recapture study has demonstrated that at least 20% the offshore lobster population moves into shoal wate the spring and summer and returns to the outer shelf upper slope by early winter. This migratory beha appears to be motivated by temperature, as the seaso distribution of tagged lobsters according to depth is correlated with bottom temperature. The extens seasonal migrations undertaken by offshore lobsters c trast sharply with the localized movements of coas stocks. This apparent difference may be partially plained by the very high exploitation rate inshore s that most lobsters of recruit size are quickly harves within the bounds of locally intensive fisheries.

Whether the offshore stocks are genetically disti from the coastal stocks has not been established, but evident that the shelf edge and upper slope is a perr nent habitat from which small- and large-scale exc sions are made with seasonal regularity. We believe t the continental slope habitat lacks sufficiently h temperatures during the summer to promote extrusio eggs, molting, and subsequent mating, and that deficiency is compensated by seasonal shoalward mig tion to warmer water. In situ observations of offsh lobsters from the research submersible *Nekton Gam* at Corsair, Lydonia, Oceanographer, Hydrographer, Veatch canyons during June-July of 1973 and 1974 s stantiate this belief. Evidence of lobster molting (s exoskeleton) was observed only at depths shoaler t 100-110 fathoms (183-201 m), whereas lobsters were tributed to depths of at least 170 fathoms (311 m).

The magnitude of variation in depth at recapture month suggests that the migration toward shoal wate not a total population response, nor is it likely a w coordinated one. We hypothesize that some lobs migrate early, some late, and some not at all. Super posed upon these variations in migratory behavior is apparent tendency of some lobsters to move laterally or west along the outer shelf and upper slope. Hence, concept of discrete canyon populations is unlikely.

SUMMARY

1. This report has presented the results of an offs lobster tag and recapture study to define the seas

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[2] Chamberlin, J. L. Bottom temperatures on the continental shelf and slope south of New England during 1974. *In* J. Goulet (editor), Environment of the United States living marine resources—1974, p. 18-1 to 18-7, figs. 18.1-18.6 (NMFS unpubl. manuscr.)

[1] Research submersible operations provided by NOAA's Manned sea Science and Technology Office.

migratory behavior and population distribution of the shore lobster population ranging from Corsair Can- n and the southeastern extremes of Georges Bank to Baltimore Canyon off the coast of Virginia. A total of 7,326 offshore lobsters were tagged and released at localities, grouped into 29 composite release ations to effect a logical pooling of release and recapture information and expedite the plotting and aluation of the data.

oper and Uzmann (1971) hypothesized, on the basis of a described time-temperature relationship, that the nature of the offshore lobster migration phenomenon s a vernal shoalward movement to warmer water h subsequent return to the outer edge of the shelf and upper slope with the onset of fall and winter. In this report we attempt to elicit qualitative and quan- ative aspects of individual movements from oupings of individuals referenced to release locality, point of recapture, and time at large.

mong the 945 recaptured lobsters, 584 (62%) were orted by specific location, 183 (19%) by generalized ation, and 178 (19%) without location information of any kind. A classification scheme is presented ich distinguishes between directed migrants and ose whose net movements over time are inconsequential or not clearly directional. We have defined a migrant as an individual that has moved a stance of 10 miles or more in 10-120 days from time release to time of recapture. A total of 117 (20% of 584) lobsters meet our requirements of defined migrants.

tween 17 and 20% of the 576 recaptured lobsters ose net movements were definable (classified movements) demonstrated seasonal shoalward migration. The highly restrictive criteria used herein for fining shoalward migrants have probably excluded a considerable number of other recaptures that had, in fact, migrated into shoaler water. Therefore, the es- nate of 17-20% annual shoalward migration is obably an underestimate. Approximately 25% of the tagged population remained localized (nonmigrants) and some portion of the remaining 55-58% the classified movements (indeterminates) might, rough more definitive criteria of classification, be assignable as shoalward migrants or nonmigrants.

Forty-three (37%) of the defined migrants (117) mov- laterally along the outer edge of the continental elf. There is no apparent reason for this lateral movement easterly or westerly during spring and mmer. Discrete submarine canyon populations em unlikely in view of these lateral movements. In contrast, 63% of the defined migrants moved into shoal water.

alysis of the depth distribution of recaptured bsters by month of capture shows a pronounced cyclical pattern of shoaling during March-August followed by a return to the shelf margin and upper pe during October-December. These cyclical anges in depth by season, independent of net track analyses, provides additional support for the hypothesis of Cooper and Uzmann (1971) of inshore-offshore movements of the offshore lobster population.

7. The distribution of recaptured lobsters by month of capture and mean bottom water temperature demonstrates that the offshore lobster population, through random and/or directed movements, maintains itself within a temperature regime of 8°-14°C.

ACKNOWLEDGMENTS

We thank National Marine Fisheries Service port agents John V. Mahoney, Churchill T. Smith, Fred C. Blossom, Paul P. Swain, and Dennis E. Main for invaluable assistance in locating, collecting, and reporting tagged lobsters taken by the commercial fishing fleet. Special thanks are due to John P. Laird, National Marine Fisheries Service, Woods Hole, for assistance with programming and execution of computer and plotter runs. The laboratory draftsmen, John R. Lamont and James A. Rollins, have our deep appreciation for their patient craftsmanship with our many requirements. Likewise, we sincerely thank Gwendolyn L. Kelley, staff typist, and Gareth W. Coffin, staff photographer, for their essential services in the final production of this report.

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APPENDIX TABLES

Key to Column Headings

RET - Return number plus F (female) or M (male) suffix on column entries
CS - Composite station number
OS - Original station number
MO - Month of recapture
RLAT - Release latitude
RLON - Release longitude
CLAT - Recapture latitude
CLON - Recapture longitude
DATL - Days at large
MIL - Miles (nautical)
CL1- Carapace length at release
CL2- Carapace length at recapture
EC - External egg code; first digit is egg code at release, second digit is egg code at recapture:
  1 - no eggs
  2 - new eggs
  3 - mature eggs
  4 - unreported
  5 - eggs, stage unreported

Appendix Table 1

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
F	1	1	5	4017	6803			421		118	118	11
23M	1	2	6	4017	6803			1191		185	212	
M	1	1	11	4017	6803	4031	6758	1342	13	119		

Appendix Table 2

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
3M	2	4	6	3959	6936	4009	6951	67	16	80	80	
17M	2	4	6	3959	6936	4002	6936	76	3	102	102	
M	2	4	4	3959	6936	VEAT		741		97	135	

Appendix Table 3

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
3F	3	5	5	3931	7213	4105	7121	29	102	96		14
11F	3	5	5	3931	7213	3938	7225	26	13	78	78	11
3F	3	5	5	3931	7213	3955	7145	6	33	90	90	11
9F	3	5	8	3931	7213	4047	7235	118	77	94	94	11
45F	3	5	8	3931	7213	3907	7243	470	34	70		14
6F	3	5	7	3931	7213	3907	7243	460	34	72		14
0F	3	5	2	3931	7213			1024		79	104	11
2M	3	5	5	3931	7213	3935	7215	15	5	74	74	
8M	3	5	8	3931	7213	HUDS		125		73		

Appendix Table 4

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
87F	4	6	1	4005	7109	4000	7106	254	6	85	99
462F	4	6	4	4005	7109			344		92	
875F	4	6	12	4005	7109			1326		69	88
7M	4	6	6	4005	7109	4009	7112	43	5	103	
12M	4	6	5	4005	7109	4005	7122	7	10	79	79
173M	4	6	6	4005	7109	4003	6938	405	71	100	
409M	4	6	12	4005	7109			597		73	108

Appendix Table 5

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
4F	5	8	6	4004	7027	4010	7016	36	11	87	
5F	5	8	5	4004	7027	4009	7026	31	6	103	103
6F	5	7	5	4005	7027	4013	7023	27	8	80	80
14F	5	7	6	4005	7027	4009	7026	34	5	81	81
15F	5	7	6	4005	7027	4004	7035	43	7	78	78
21F	5	8	7	4004	7027			83		82	
26F	5	8	6	4004	7027	4001	6938	36	38	100	100
27F	5	7	6	4005	7027	4001	6938	37	38	107	107
28F	5	7	6	4005	7027	4045	6938	50	56	124	124
36F	5	7	8	4005	7027			93		67	
37F	5	8	8	4004	7027			92		169	
43F	5	7	9	4005	7027	4006	6930	127	44	93	
44F	5	7		4005	7027					94	
53F	5	7	11	4005	7027	4019	6849	191	76	111	
58F	5	8	11	4004	7027	4015	7002	199	23	111	
60F	5	7	12	4005	7027	4011	7016	216	10	110	
82F	5	8	1	4004	7027	3957	7013	274	14	89	103
377F	5	8	11	4004	7027	4016	7017	564	15	73	
456F	5	7	2	4005	7027			657		87	100
487F	5	7	5	4005	7027	4002	6907	735	61	99	112
498F	5	8	5	4004	7027	VEAT		740		79	
551F	5	7	6	4005	7027	4000	7039	774	10	88	
16M	5	8	6	4004	7027	4004	7035	42	7	76	76
40M	5	8		4004	7027					99	99
68M	5	7	12	4005	7027	4003	7017	236	7	80	96
76M	5	8	1	4004	7027	3959	7054	257	22	77	77
398M	5	8	11	4004	7027	4020	6934	569	44	93	108
521M	5	7	5	4005	7027			747		72	
535M	5	8	6	4004	7027			767		98	116

Appendix Table 6

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
9F	6	11	6	3957	6953	3958	6918	36	27	79	79	11
0F	6	9	6	3958	6959	4003	6929	33	24	88		11
18F	6	9	6	3958	6959	4003	6936	49	18	84	84	11
9F	6	9	6	3958	6959	4003	6936	49	18	99	99	11
7F	6	9	11	3958	6959	4018	6849	197	57	123		14
67F	6	9	12	3958	6959	4003	7017	234	15	119	119	11
1F	6	11	1	3957	6953	4000	7008	259	10	92	92	12
3F	6	9	1	3958	6959	4002	6906	259	41	113	127	31
6F	6	9	1	3958	6959	3957	7054	252	42	102	102	31
91F	6	11	1	3957	6953	4013	6832	266	63	83	83	12
4F	6	9	9	3958	6959	4006	7130	496	71	84		14
6F	6	9	11	3958	6959	VEAT		563		114		31
1M	6	9	5	3958	6959	4000	7118	12	62	101	101	
0M	6	9	6	3958	6959	4003	6936	49	18	86	86	
50M	6	9	11	3958	6959	4016	7002	187	19	83	99	
0M	6	9	1	3958	6959	4000	6937	262	17	89		
5M	6	9	1	3958	6959	4001	7012	274	11	104	104	
3M	6	11	7	3957	6953	4040	6926	435	47	96	115	
279M	6	11	7	3957	6953			425		74		
3M	6	11	1	3957	6953	4006	6840	616	58	87	102	
3M	6	9	10	3958	6959	4015	6955	896	18	67		
56M	6	9	2	3958	6959			1020		99		

Appendix Table 7

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
74F	7	10	1	3956	6942	3955	6940	256	1	100	114	31
4F	7	10	1	3956	6942	4001	7012	272	23	83	98	11
4F	7	10	4	3956	6942	4000	6912	336	23	100	100	11
12F	7	10	4	3956	6942	3958	6914	354	21	132	132	11
38F	7	10	1	3956	6942			624		109	127	11
5F	7	10	5	3956	6942	4009	6903	739	31	96	109	11
4F	7	10	6	3956	6942	4054	6941	771	58	90	103	11
8M	7	10	6	3956	6942	4009	7115	39	72	111	111	
7M	7	10	1	3956	6942	4000	6937	626	5	71	101	
38M	7	10	5	3956	6942			753		86		

Appendix Table 8

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
39F	8	12	8	3959	7003	HUDS		74		84	
156M	8	12	5	3959	7003	4031	6740	350	114	91	
245M	8	12		3959	7003					100	120
546M	8	12	6	3959	7003	3957	6929	734	26	111	130

Appendix Table 9

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
47F	9	13	10	4003	7018	4015	6923	132	43	89	104
62F	9	13	12	4003	7018	VEAT		178		88	101
69F	9	13	1	4003	7018	3957	7044	204	22	83	
105F	9	13	4	4003	7018	4002	7028	298	8	93	93
381F	9	13	11	4003	7018	4025	6915	533	51	86	99
413F	9	13	12	4003	7018			545		75	100
429F	9	13	1	4003	7018			561		94	108
439F	9	13	1	4003	7018	4000	7034	592	13	76	102
693F	9	13	6	4003	7018	3958	6926	1087	40	76	
713F	9	13	2	4003	7018	3956	6955	975	19	72	
908F	9	13	6	4003	7018	3955	6935	1453	34	76	100
66M	9	13	12	4003	7018	4003	7017	189	2	140	140
389M	9	13	11	4003	7018	4020	6934	533	37	74	104
406M	9	13	12	4003	7018	VEAT		547		87	103
420M	9	13	12	4003	7018			548		72	
453M	9	13	2	4003	7018	4001	6908	605	54	73	
457M	9	13	2	4003	7018			610		91	130
515M	9	13	5	4003	7018	4001	7054	704	28	82	
946M	9	13	3	4003	7018	4035	6755	1549	118	101	165

Appendix Table 10

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
34F	10	14	7	4013	7031	4013	7010	39	16	76	76
41F	10	14	8	4013	7031	4022	7052	60	20	76	
30M	10	14	8	4013	7031	4013	7024	46	6	69	

Appendix Table 11

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
1F	11	15	7	4013	7015	4017	7007	30	7	71		14
3F	11	15	1	4013	7015	4001	7012	227	12	87	99	12
90F	11	15	2	4013	7015	3959	7012	231	14	72	83	11
499F	11	15	5	4013	7015	4006	6839	695	74	93	107	11
3F	11	15	6	4013	7015	4011	6849	727	65	98		14
94M	11	15	2	4013	7015	3955	6933	253	37	117	117	

Appendix Table 12

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
136F	12	16	6	4012	7114	3955	7154	358	35	97	97	11
8M	12	16	10	4012	7114	4012	7119	120	4	113	113	
2M	12	16	1	4012	7114	4000	7008	214	52	102	120	

Appendix Table 13

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
22F	13	17	7	4004	7150	4000	7122	14	23	91		1
24F	13	17		4004	7150					91	91	5
25F	13	17	7	4004	7150	4037	7318	28	75	97	97	5
32F	13	19	8	4005	7143	4000	7153	56	9	78	90	1
61F	13	19	12	4005	7143	4009	7022	174	63	88	103	1
63F	13	18	12	4006	7148	3908	7241	178	70	79	103	1
64F	13	18	12	4006	7148	3848	7302	183	96	99	99	1
65F	13	18	12	4006	7148	4001	7039	182	52	79	93	1
78F	13	19		4005	7143					83		1
81F	13	19	1	4005	7143	3957	7013	224	71	88	88	1
99F	13	17	3	4004	7150			259		95	109	3
115F	13	19		4005	7143					68		1
164F	13	19	5	4005	7143			345		92	107	1
267F	13	18	7	4006	7148			397		98		5
270F	13	19	6	4005	7143	3956	7145	375	9	85	85	1
297F	13	17	6	4004	7150			350		87		1
335F	13	18	9	4006	7148	4045	7240	465	56	92	105	1
353F	13	19	10	4005	7143	4044	7116	484	45	65	83	1
407F	13	17	12	4004	7150	VEAT		544		87	101	3
486F	13	19	5	4005	7143	4007	6936	681	98	90	102	1
615F	13	19	8	4005	7143			792		85	98	1
618F	13	18	9	4006	7148			824		89	102	1
772F	13	17	7	4004	7150	VEAT		1121		79	109	4
879F	13	17	11	4004	7150	4005	6935	1228	104	97		5
905F	13	18	3	4006	7148	3908	7243	1360	72	88		4
42M	13	17	8	4004	7150	4022	7054	58	47	72		
59M	13	17	11	4004	7150	4017	7012	158	76	86	103	
92M	13	17	1	4004	7150	VEAT		227		89		
95M	13	17	2	4004	7150	4012	7119	235	25	87		
106M	13	17	4	4004	7150	3950	7149	302	14	97		
108M	13	17	2	4004	7150	4007	7123	238	21	94		
175M	13	18	6	4006	7148	3957	7157	353	11	85	97	
250M	13	18	7	4006	7148			381		86		
268M	13	18	7	4006	7148			378		107		
325M	13	17	8	4004	7150			434		103		
472M	13	17	4	4004	7150			655		94	132	
585M	13	18	9	4006	7148	4007	7058	816	39	98	137	
649M	13	17	1	4004	7150	4008	7132	941	15	98	137	
742M	13	18	10	4006	7148			1215		75		
870M	13	18	12	4006	7148	4005	6925	1267	108	89		

Appendix Table 14

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
35F	14	21	9	4005	7138	4003	7134	79	6	82		14
49F	14	21	10	4005	7138	4023	6944	129	89	94	108	11
80F	14	20	1	4007	7138	3952	7147	224	16	89	102	11
93F	14	21	2	4005	7138	BLOC		235		77		14
96F	14	20	3	4007	7138	3910	7229	262	69	87	87	12
147F	14	20	5	4007	7138	3958	7127	341	12	79	93	11
174F	14	20	6	4007	7138					80		14
35F	14	20	7	4007	7138	4008	7006	376	71	91		15
322F	14	21	9	4005	7138	4012	7107	441	26	74		14
323F	14	20	9	4007	7138	4012	7107	441	25	95		12
30F	14	20	7	4007	7138	4010	6939	378	91	87		14
347F	14	21	5	4005	7138	4045	7243	365	65			
348F	14	21	5	4005	7138	4046	7238	365	62			
49F	14	21	5	4005	7138	4048	7230	365	59			
50F	14	21	5	4005	7138	4049	7228	365	58			
430F	14	21	1	4005	7138			556		88	101	11
446F	14	21	12	4005	7138	4004	7135	546	4	81	93	12
04F	14	21	5	4005	7138	4005	7135	689	2	82	96	13
726F	14	20	6	4007	7138	4029	6743	1077	181	91	121	14
33M	14	21	8	4005	7138	4000	7153	55	12	98	98	
79M	14	21	1	4005	7138	3941	7152	222	26	92	107	
151M	14	20	5	4007	7138	3956	7003	328	73	95		
69M	14	20	7	4007	7138	4044	7246	392	65	100	117	
22M	14	20	12	4007	7138	4009	7130	556	7	104	126	
634M	14	21	10	4005	7138	3958	7124	836	13	123		

Appendix Table 15

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
51F	15	22	11	4142	6652	4136	6648	44	7	117		14
107F	15	22	5	4142	6652	4137	6627	227	19	136		14
289F	15	22	8	4142	6652	4139	6700	321	7	86	86	11
548F	15	22	6	4142	6652	4109	6620	640	41	157		14
607F	15	22	7	4142	6652			666		151	163	11
20F	15	22	10	4142	6652	4130	6654	759	12	107	121	11
77M	15	22	1	4142	6652			132		141	141	
130M	15	22	5	4142	6652			231		142	142	
286M	15	22	8	4142	6652	4140	6705	321	10	156	156	
724M	15	22	6	4142	6652			1002		167		

Appendix Table 16

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
45F	16	23	10	4031	6837	4034	6927	20	38	98	98
52F	16	25	11	4029	6837	4018	6907	38	25	86	
55F	16	26	11	4035	6842	4032	6906	55	18	85	
98F	16	25	3	4029	6837	4004	6852	173	27	96	96
100F	16	26	3	4035	6842	4014	6817	171	28	105	105
114F	16	24	4	4030	6836			215		90	100
165F	16	24	6	4030	6836	4002	6933	250	52	104	104
176F	16	26	6	4035	6842	4008	7027	257	84	92	92
241F	16	24	6	4030	6836	4024	6816	250	15	103	103
367F	16	26	11	4035	6842			415		83	100
434F	16	26	12	4035	6842	HYDR		447		94	
449F	16	23	2	4031	6837	VEAT		514		102	
539F	16	26	5	4035	6842			231		115	
559F	16	25	6	4029	6837	4020	6818	640	17	120	
616F	16	26	9	4035	6842	VEAT		719		108	
629F	16	26	10	4035	6842	HYDR		735		105	117
731F	16	23	6	4031	6837			981		84	110
732F	16	26	6	4035	6842			980		85	120
749F	16	26	8	4035	6842	4015	6855	1062	21	86	100
762F	16	25	7	4029	6837	OCEA		1034		98	
46M	16	24	10	4030	6836	4034	6927	20	39	123	123
54M	16	25	11	4029	6837	4032	6906	56	22	96	
75M	16	25	1	4029	6837	3959	6937	113	54	92	92
88M	16	26	10	4035	6842	4022	6850	7	14	98	
89M	16	25	10	4029	6837	4022	6850	8	12	85	
97M	16	26	3	4035	6842	4004	6852	172	31	90	90
101M	16	24	3	4030	6836	4005	6850	177	27	107	107
102M	16	26	4	4035	6842	4019	6809	189	29	128	128
103M	16	24	4	4030	6836	4019	6809	191	23	92	92
109M	16	25	4	4029	6837	4015	7016	194	77	101	
110M	16	25	4	4029	6837	4014	6810	203	26	120	120
113M	16	24	4	4030	6836			215		100	100
116M	16	25	5	4029	6837	VEAT		237		137	
139M	16	24	5	4030	6836	4007	6905	237	32	79	89
145M	16	23		4031	6837					99	99
157M	16	26	6	4035	6842	4007	6908	248	34	109	109
159M	16	26	6	4035	6842	4008	6845	252	26	83	83
170M	16	25	6	4029	6837			249		116	
195M	16	26	6	4035	6842	4012	6840	269	23	131	131
197M	16	25	6	4029	6837	4012	6840	269	17	122	122
220M	16	25	6	4029	6837	4010	6841	272	19	93	93
223M	16	23	6	4031	6837	4016	6829	275	15	104	104
224M	16	24	6	4030	6836	4008	6907	275	32	109	109
257M	16	25	7	4029	6837			290		107	107
296M	16	25	6	4029	6837			251		86	
362M	16	25	11	4029	6837	4206	6734	411	107	76	

Appendix Table 16 Cont.

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
9M	16	23	10	4031	6837	4109	6707	384	79	90		
1M	16	25	12	4029	6837	4010	6902	439	27	74	86	
3M	16	25	4	4029	6837	VEAT		557		84	99	
9M	16	24	6	4030	6836			620		80	95	
0M	16	25	5	4029	6837	4005	6915	612	38	156		
2M	16	25	6	4029	6837	4015	6845	641	16	94		
3M	16	25	7	4029	6837	4035	7009	648	70	76	96	
8M	16	25	10	4029	6837	HYDR		736		106	125	
1M	16	26	9	4035	6842	4032	6735	1077	51	126		
9M	16	25	10	4029	6837	4016	6812	1103	23	83	147	
8M	16	23	7	4031	6837	4025	6810	1380	21	117	165	
2M	16	25	8	4029	6837	4028	6725	1407	55	96	143	
3M	16	25	7	4029	6837			1381		105		

Appendix Table 17

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
131F	17	28	5	4033	6745			206		156	156	1
132F	17	27	5	4029	6739	3956	6931	201	92	132	132	1
140F	17	27	5	4029	6739	4018	6810	208	26	130	130	1
232F	17	27	6	4029	6739	4026	6733	256	5	81		1
234F	17	28	7	4033	6745	4033	6740	259	4	105	105	3
357F	17	28	10	4033	6745	4129	6728	353	58	140	140	1
481F	17	27	4	4029	6739	4026	6725	560	10	126	126	1
508F	17	28	5	4033	6745	4013	6831	577	41	100	115	1
590F	17	27		4029	6739	HYDR	WELK			100		1
591F	17	27		4029	6739	HYDR	WELK			97		1
768F	17	27	7	4029	6739	4142	6714	1010	76	117		4
784F	17	28	10	4033	6745	LYDU		1107		104		4
786F	17	27		4029	6739					119		1
940F	17	27	7	4029	6739			1367		108		5
56M	17	27	11	4029	6739	4039	6704	39	29	199		
117M	17	28	5	4033	6745	VEAT		216		121		
144M	17	27		4029	6739					109	109	
167M	17	28	6	4033	6745			229		98	98	
233M	17	28	7	4033	6745	4033	6740	259	4	116	116	
587M	17	28		4033	6745	HYDR	WELK			118		
588M	17	27		4029	6739	HYDR	WELK			74		
589M	17	28		4033	6745	HYDR	WELK			107		
744M	17	27	10	4029	6739	4033	6755	1091	12	132		
934M	17	27	7	4029	6739	4030	6810	1372	24	119		
937M	17	27	6	4029	6739	4150	6957	973	132	109		
938M	17	27	6	4029	6739	4020	6733	1338	11	114		
943M	17	28	8	4033	6745			1413		108	120	

Appendix Table 18

	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
5F	18	29	5	3958	6928			15		71		14
F	18	29	5	3958	6928			15		79		14
3F	18	29	5	3958	6928	3956	6931	4	4	103	103	55
5F	18	29	5	3958	6928			19		75		14
3F	18	30	6	3959	6925	4007	6908	31	16	72	72	11
3F	18	29		3958	6928					84	84	41
6F	18	29	6	3958	6928	4007	6908	32	18	91	91	11
0F	18	32	6	4000	6934	4007	6928	41	9	80	80	11
2F	18	29	6	3958	6928	4007	6928	43	9	77	77	11
3F	18	32	6	4000	6934	4007	6928	41	9	80	80	11
1F	18	29	6	3958	6928			56		80	80	11
1F	18	32	6	4000	6934	4002	6918	54	12	109	109	11
0F	18	32	6	4000	6934	4054	6843	32	66	101	101	11
9F	18	29	7	3958	6928	4059	7305	71	186	90		11
4F	18	30	7	3959	6925	4040	6926	71	41	121	121	31
5F	18	30	7	3959	6925			72		86	86	11
3F	18	30	7	3959	6925	4113	6946	80	76	116	116	11
1F	18	32	7	4000	6934	4004	7009	85	27	68	68	11
3F	18	32	8	4000	6934	4007	6905	102	25	71		14
1F	18	32	8	4000	6934	VEAT		91		82	82	11
5F	18	29	6	3958	6928			34		86		14
8F	18	29	8	3958	6928	4000	6937	122	7	80	93	11
9F	18	32	8	4000	6934			118		83	83	11
9F	18	29	7	3958	6928			64		92		14
0F	18	29	9	3958	6928	3957	6932	129	3	68	82	11
3F	18	32	10	4000	6934			156		87		14
5F	18	30	10	3959	6925	4058	7015	166	70	97	113	11
8F	18	29	10	3958	6928	4008	6904	181	21	74		14
1F	18	29	10	3958	6928	4003	6936	175	8	86	115	11
9F	18	29	11	3958	6928			199		76	91	11
1F	18	30	11	3959	6925			198		72	86	11
5F	18	29	11	3958	6928	4022	6941	207	24	73	89	11
6F	18	32	11	4000	6934	4022	6941	205	21	76	89	11
0F	18	32	11	4000	6934	HYDR		199		68	82	11
2F	18	32	11	4000	6934	4020	6934	212	20	75	90	11
5F	18	29	12	3958	6928	4013	6934	221	16	79	93	11
5F	18	29	12	3958	6928	VEAT		233		72		14
0F	18	29	12	3958	6928			226		97	112	31
7F	18	29	12	3958	6928			229		70		14
1F	18	32	12	4000	6934			227		69		14
7F	18	29	1	3958	6928			259		69	82	11
8F	18	32	1	4000	6934			257		83	98	11
1F	18	30	1	3959	6925			258		81	96	11
0F	18	29	1	3958	6928	4001	6908	275	15	73	86	11
5F	18	32	1	4000	6934	4003	7010	258	28	88		14
8F	18	32	2	4000	6934	VEAT		295		88	102	11
0F	18	30	1	3959	6925			274		75	88	11
4F	18	32	2	4000	6934	4001	6908	284	20	92		14
5F	18	30	2	3959	6925			290		71	85	11
1F	18	29	6	3958	6928	4000	6925	41	2	87		14

Appendix Table 18 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
468F	18	29	4	3958	6928			336		89	
469F	18	32	4	4000	6934			334		107	
470F	18	32	4	4000	6934			334		77	
471F	18	32	4	4000	6934			334		72	
476F	18	32	4	4000	6934	VEAT		340		82	82
477F	18	29	4	3958	6928	4028	6710	344	110	140	154
478F	18	32	4	4000	6934	4014	6815	352	60	74	86
483F	18	30	5	3959	6925	3953	6926	367	5	85	102
485F	18	29	5	3958	6928	4007	6936	366	11	88	100
494F	18	29	5	3958	6928	4009	6903	376	21	86	93
500F	18	29	5	3958	6928	4006	6839	377	38	88	112
509F	18	29	5	3958	6928	4013	6831	381	46	101	
513F	18	32	5	4000	6934	3956	6935	383	4	60	71
516F	18	32	6	4000	6934	4005	6945	395	9	91	91
518F	18	30	6	3959	6925	3957	6925	396	2	83	
520F	18	32	6	4000	6934	3957	6925	395	8	71	
525F	18	32	6	4000	6934	HYDR		402		77	91
533F	18	32	6	4000	6934			400		61	75
537F	18	32	5	4000	6934			388		97	97
547F	18	29	6	3958	6928	4043	6938	416	45	75	90
560F	18	29	7	3958	6928	4004	6935	430	9	68	
572F	18	29	6	3958	6928	VEAT		411		73	
573F	18	30	7	3959	6925	VEAT		428		75	90
596F	18	29		3958	6928	HYDR	WELK			86	
599F	18	32	8	4000	6934	4010	6908	474	22	90	104
603F	18	30	8	3959	6925	4004	7049	462	64	73	
604F	18	29	8	3958	6928	4004	7049	463	62	85	
608F	18	32	7	4000	6934			433		73	82
609F	18	32	6	4000	6934	3957	6934	409	3	88	
612F	18	29	3	3958	6928	4004	6928	319	6	75	
622F	18	29	10	3958	6928	HYDR		519		86	99
623F	18	30	10	3959	6925	HYDR		518		88	103
632F	18	32	11	4000	6934	4033	6931	548	32	59	85
667F	18	32	4	4000	6934	3956	6919	701	12	80	94
669F	18	29	3	3958	6928			688		75	92
676F	18	32	5	4000	6934	4012	6906	750	25	103	116
678F	18	32	6	4000	6934	HYDR		409		75	105
679F	18	32	6	4000	6934	HYDR		409		81	
730F	18	32	6	4000	6934	4015	6845	773	41	65	91
800F	18	29	6	3958	6928	VEAT		42		77	
801F	18	29	6	3958	6928	VEAT		42		82	
803F	18	32	6	4000	6934	VEAT		40		90	
804F	18	32	9	4000	6934	VEAT	HYDR	866		61	97
849F	18	30	11	3959	6925	4035	6825	921	59	85	116
857F	18	29	11	3958	6928	4031	6758	931	78	102	
863F	18	30	12	3959	6925	4005	6925	950	7	81	
894F	18	32	12	4000	6934			957		77	
944F	18	29	9	3959	6925			1238		75	100

Appendix Table 18 Cont.

	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
122M	18	30	5	3959	6925	VEAT		19		81		
[illegible]	18	29	5	3958	6928	VEAT		20		71		
[illegible]	18	29	5	3958	6928	VEAT		20		83		
127M	18	29	5	3958	6928			10		94	94	
[illegible]	18	30	5	3959	6925			9		90	90	
[illegible]	18	29	5	3958	6928	3956	6931	4	4	87	87	
135M	18	29	5	3958	6928	3956	6931	4	4	100	100	
136M	18	29	5	3958	6928	3956	6931	4	4	70	88	
[illegible]	18	29		3958	6928					91	91	
[illegible]	18	30	5	3959	6925			18		81		
154M	18	29	5	3958	6928			19		73		
[illegible]	18	29	6	3958	6928	4006	6905	36	20	102	102	
[illegible]	18	30	6	3959	6925	4007	6928	42	9	99	99	
181M	18	29	6	3958	6928	4007	6928	43	9	75	75	
[illegible]	18	32	6	4000	6934	4009	6933	45	9	92		
[illegible]	18	32		4000	6934					90	90	
199M	18	29	6	3958	6928	4013	6843	52	37	153	153	
201M	18	32	6	4000	6934	4013	6843	50	41	174	174	
[illegible]	18	30	6	3959	6925			55		82	82	
[illegible]	18	32	6	4000	6934			54		90	90	
216M	18	32	6	4000	6934	3958	6939	54	5	161		
[illegible]	18	29	6	3958	6928	3958	6939	56	9	130		
[illegible]	18	29	6	3958	6928	4000	6922	58	6	88	88	
226M	18	29	6	3958	6928			60		71	82	
[illegible]	18	29	7	3958	6928	4000	6937	81	7	101	101	
[illegible]	18	29	7	3958	6928	4000	6937	81	7	65	88	
266M	18	29	7	3958	6928	4007	6952	85	21	89	89	
272M	18	29	7	3958	6928	3958	6923	62	3	94	94	
[illegible]	18	30	7	3959	6925	3958	6923	62	1	85		
[illegible]	18	29	8	3958	6928	VEAT		93		94	107	
300M	18	29	7	3958	6928	4003	6908	82	16	86		
[illegible]	18	29	8	3958	6928	4036	6923	106	39	96	96	
[illegible]	18	30	9	3959	6925	4008	6931	125	10	74	90	
313M	18	32	9	4000	6934	4008	6931	124	8	96	96	
326M	18	30	6	3959	6925			55		96		
[illegible]	18	30	7	3959	6925			63		97		
[illegible]	18	29	7	3958	6928			64		90		
333M	18	29	9	3958	6928	4014	6913	143	20	87		
[illegible]	18	32	11	4000	6934	4113	6703	190	137	66		
[illegible]	18	32	10	4000	6934	4003	6936	173	3	81	110	
364M	18	32	11	4000	6934	4013	6916	191	20	71	87	
[illegible]	18	32	11	4000	6934			197		78	91	
[illegible]	18	32	11	4000	6934			197		68	83	
374M	18	29	11	3958	6928			199		78		
382M	18	32	11	4000	6934	4020	6934	212	20	85	102	
[illegible]	18	32	11	4000	6934	4020	6934	212	20	103	124	
367M	18	32	11	4000	6934	4020	6934	212	20	100	100	
388M	18	32	11	4000	6934	4020	6934	212	20	98	98	
[illegible]	18	32	11	4000	6934	4020	6934	212	20	91	107	
[illegible]	18	29	11	3958	6928	4020	6934	214	22	75	84	

Appendix Table 18 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
393M	18	29	11	3958	6928	4020	6934	214	22	87	107
394M	18	29	12	3958	6928			219		103	
396M	18	32	12	4000	6934	4013	6934	219	13	66	78
397M	18	29	11	3958	6928	4020	6934	204	22	76	89
400M	18	32	12	4000	6934	4006	6901	222	25	64	75
402M	18	32	12	4000	6934	4009	6904	220	24	110	110
404M	18	30	12	3959	6925	4009	6904	223	19	81	99
408M	18	30	12	3959	6925			225		81	101
411M	18	32	12	4000	6934			224		79	79
412M	18	29	12	3958	6928			226		82	100
414M	18	30	12	3959	6925			225		71	87
415M	18	32	12	4000	6934			224		86	102
416M	18	29	12	3958	6928			229		77	
418M	18	30	12	3959	6925			228		91	
419M	18	32	12	4000	6934			227		126	
425M	18	32	1	4000	6934			257		79	92
426M	18	32	1	4000	6934			257		63	76
435M	18	29	12	3958	6928	HYDR		231		117	
442M	18	29	1	3958	6928			260		71	
443M	18	32	12	4000	6934	4001	6907	236	19	92	
447M	18	29	11	3958	6928			199		95	112
451M	18	30	2	3959	6925	4001	6908	285	13	74	
452M	18	30	2	3959	6925	4001	6908	285	13	81	
458M	18	29	6	3958	6928	4000	6925	41	2	100	
459M	18	32	6	4000	6934	4000	6925	39	6	112	
460M	18	30	6	3959	6925	4000	6925	40		81	
464M	18	30	4	3959	6925	VEAT		348		72	90
474M	18	32	4	4000	6934	VEAT		339		61	90
475M	18	30	4	3959	6925	VEAT		340		67	81
484M	18	32	5	4000	6934	4007	6936	364	7	92	106
488M	18	32	5	4000	6934	4002	6907	365	22	80	97
492M	18	29	5	3958	6928	VEAT		368		81	97
503M	18	29	5	3958	6928	4035	6737	374	92	120	120
514M	18	32	5	4000	6934	3956	6935	383	4	67	90
517M	18	29	6	3958	6928	4005	6945	397	14	68	92
519M	18	29	6	3958	6928	3957	6925	397	2	90	
523M	18	29	5	3958	6928			394		80	95
526M	18	32	6	4000	6934	HYDR		402		94	94
531M	18	32	6	4000	6934			400		80	95
536M	18	29	5	3958	6928			390		191	191
541M	18	29	5	3958	6928	4006	6926	371	8	85	100
542M	18	30	5	3959	6925	4006	6926	370	7	84	98
555M	18	32	6	4000	6934	4009	6905	422	23	92	110
571M	18	32	6	4000	6934	VEAT		409		91	112
582M	18	30	9	3959	6925	4009	6906	512	17	67	
583M	18	32	9	4000	6934			487		70	
605M	18	29	8	3958	6928	4004	7049	463	62	86	
613M	18	29	3	3958	6928	4004	6928	319	6	106	
617M	18	30	9	3959	6925			507		108	118
619M	18	32	10	4000	6934	4021	6915	528	25	76	112

Appendix Table 18 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
621M	18	29	10	3958	6928	HYDR		519		65	85	
M	18	30	10	3959	6925	HYDR		518		92	110	
M	18	32	10	4000	6934	HYDR		517		83	115	
639M	18	32	11	4000	6934			572		83	121	
647M	18	29	1	3958	6928	4010	6823	620	50	66	96	
M	18	29	2	3958	6928			656		86		
714M	18	29	1	3958	6928	4005	6935	620	8	97		
720M	18	29	5	3958	6928	4125	7056	761	110	82		
M	18	32	8	4000	6934	HYDR		840		73	102	
M	18	32	11	4000	6934	HYDR		920		68	131	
799M	18	29	6	3958	6928			48		95		
M	18	32	6	4000	6934	VEAT		40		146		
M	18	30	4	3959	6925	HYDR		703		73	104	
852M	18	32	11	4000	6934	4040	6810	927	75	69	118	
893M	18	30		3959	6925	HYDR				105		

Appendix Table 19

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
137F	19	31	5	4004	6917	3957	6919	15	6	96	96
146F	19	31	5	4004	6917	4012	6907	24	11	77	77
152F	19	31	6	4004	6917	3958	6930	29	11	94	
162F	19	31	6	4004	6917	VEAT		30		85	85
184F	19	31	6	4004	6917	4006	6935	40	15	87	87
191F	19	31	6	4004	6917	4009	6933	43	14	90	
212F	19	31	6	4004	6917			52		78	78
219F	19	31	6	4004	6917	4000	6922	55	5	76	76
225F	19	31	6	4004	6917			56		80	80
255F	19	31	7	4004	6917	4046	6930	70	45	115	115
273F	19	31	7	4004	6917	3958	6923	58	7	82	82
274F	19	31	7	4004	6917	3958	6923	59	7	88	
282F	19	31	8	4004	6917	4007	6905	100	10	87	
294F	19	31	8	4004	6917	4117	7119	107	118	92	92
298F	19	31	7	4004	6917	4003	6908	78	7	67	
299F	19	31	7	4004	6917	4003	6908	78	7	73	
301F	19	31	7	4004	6917	4003	6908	78	7	75	
302F	19	31	7	4004	6917	4003	6908	78	7	87	
320F	19	31	9	4004	6917	4010	6905	136	11	79	
321F	19	31	9	4004	6917	4010	6905	136	11	95	
332F	19	31	9	4004	6917	4014	6913	139	11	68	
334F	19	31	9	4004	6917	4049	6937	137	48	95	95
372F	19	31	11	4004	6917			195		68	83
386F	19	31	11	4004	6917	4020	6934	210	22	68	82
423F	19	31	1	4004	6917					88	99
424F	19	31	1	4004	6917					85	98
467F	19	31	4	4004	6917	VEAT		347		94	94
490F	19	31	5	4004	6917	4002	6907	363	9	70	93
505F	19	31	5	4004	6917	4009	6904	376	12	86	101
507F	19	31	5	4004	6917	4010	6845	379	25	60	80
510F	19	31	5	4004	6917	4013	6831	377	36	94	
524F	19	31	5	4004	6917	HYDR		390		80	
527F	19	31	6	4004	6917	HYDR		400		72	98
528F	19	31	6	4004	6917	HYDR		400		69	83
534F	19	31	6	4004	6917			398		68	82
543F	19	31	6	4004	6917	4013	7003	401	37	104	104
545F	19	31	6	4004	6917	3957	6929	410	12	85	100
554F	19	31	6	4004	6917	4009	6905	420	10	84	93
586F	19	31	9	4004	6917	4040	6939	504	41	86	97
602F	19	31	6	4004	6917	4008	6906	393	8	68	
610F	19	31	7	4004	6917	4048	6812	443	66	97	111
614F	19	31	3	4004	6917	4004	6928	315	9	71	
626F	19	31	10	4004	6917	HYDR		515		71	96
638F	19	31	11	4004	6917	4034	6933	563	33	70	86
640F	19	31	12	4004	6917	4007	6939	576	18	63	91
641F	19	31	12	4004	6917	4007	6939	576	18	87	98
643F	19	31	1	4004	6917			607		76	
654F	19	31	6	4004	6917	4034	7003	41	47	77	
655F	19	31	2	4004	6917			658		84	97
668F	19	31	4	4004	6917	3954	6932	699	14	98	112

Appendix Table 19 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
671F	19	31	5	4004	6917	4016	6832	736	35	60	90	14
3F	19	31	5	4004	6917	3956	6921	744	8	96	111	11
717F	19	31	1	4004	6917	HYDR		251		72	93	14
729F	19	31	6	4004	6917	HYDR		767		60		14
7F	19	31	8	4004	6917	HYDR		842		90	102	14
1F	19	31		4004	6917	HYDR				57		14
892F	19	31		4004	6917	HYDR				86		14
8M	19	31	5	4004	6917	VEAT		16		85		
119M	19	31	5	4004	6917	VEAT		17		86		
120M	19	31	5	4004	6917	VEAT		16		72		
1M	19	31	5	4004	6917	VEAT		16		76		
141M	19	31		4004	6917					96	96	
142M	19	31		4004	6917					109	109	
8M	19	31	6	4004	6917	VEAT		29		80		
8M	19	31	5	4004	6917			16		95		
190M	19	31	6	4004	6917	4009	6933	43	14	76		
4M	19	31	6	4004	6917	4007	6939	42	17	88	88	
5M	19	31	6	4004	6917	4000	6918	51	3	76		
246M	19	31	7	4004	6917	4049	6946	67	51	99	99	
290M	19	31	7	4004	6917	4004	7009	83	40	78		
7M	19	31	7	4004	6917	4133	6722	86	125	147		
331M	19	31	9	4004	6917	4014	6913	139	11	81		
344M	19	31	10	4004	6917			154		78		
6M	19	31	10	4004	6917			164		85		
3M	19	31	11	4004	6917	HYDR		195		90		
365M	19	31	11	4004	6917	4020	6941	199	26	115	133	
6M	19	31	11	4004	6917			195		103	125	
0M	19	31	11	4004	6917			195		73	89	
384M	19	31	11	4004	6917	4020	6934	210	22	107	125	
385M	19	31	11	4004	6917	4020	6934	210	22	78	96	
3M	19	31	12	4004	6917	4009	6904	220	10	69	84	
1M	19	31	1	4004	6917	4005	6908	270	7	78	91	
444M	19	31	1	4004	6917	4000	6937	255	16	115		
0M	19	31	4	4004	6917	4029	6711	335	98	74	89	
2M	19	31	5	4004	6917	3954	6926	364	11	75		
489M	19	31	5	4004	6917	4002	6907	363	9	81	97	
491M	19	31	5	4004	6917	VEAT		364		87	106	
6M	19	31	5	4004	6917	4009	6903	372	11	113	128	
501M	19	31	5	4004	6917	4006	6839	373	28	109		
512M	19	31	5	4004	6917	3956	6935	381	16	75	113	
0M	19	31	6	4004	6917			398		119	127	
2M	19	31	6	4004	6917			398		80	96	
561M	19	31	7	4004	6917	4049	6929	426	47	89	106	
0M	19	31	7	4004	6917	3954	7147	425	115	98	118	
4M	19	31	6	4004	6917	3957	7002	394	35	83		
577M	19	31	10	4004	6917	4117	6849	522	78	86	125	

Appendix Table 19 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
598M	19	31		4004	6917	HYDR	WELK			76	
601M	19	31	8	4004	6917	VEAT		461		73	88
624M	19	31	10	4004	6917	HYDR		515		95	111
642M	19	31	1	4004	6917			607		56	
677M	19	31	6	4004	6917	HYDR		407		73	
715M	19	31	4	4004	6917	HYDR		710		67	101
756M	19	31	8	4004	6917	HYDR		842		63	99
884M	19	30		3959	6925					81	

Appendix Table 20

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
148F	20	34	5	4101	6639	4113	6615	22	22	159	159	31
1F	20	33	6	4057	6635	4042	6656	27	22	121	121	31
9F	20	34	6	4101	6639			25		123		14
171F	20	33	6	4057	6635	4107	6626	34	11	146	146	11
2F	20	34	6	4101	6639	4059	6629	32	8	119	119	55
3F	20	33	6	4057	6635	4045	6649	42	16	115	115	31
207F	20	35	6	4101	6629	4103	6625	46	3	128	128	55
209F	20	34	6	4101	6639	4103	6625	46	10	129		55
3F	20	35	6	4101	6629	4053	6639	50	11	153	153	11
9F	20	34	6	4101	6639	4103	6625	48	10	133		11
244F	20	33	7	4057	6635	4120	6653	60	27	111	111	11
7F	20	34	7	4101	6639	4119	6638	62	18	130	130	55
2F	20	34	7	4101	6639	4129	6701	66	32	129	129	11
259F	20	35	7	4101	6629	4140	6702	70	47	145		14
6F	20	34	7	4101	6639	4139	6700	79	41	139	139	11
7F	20	34	7	4101	6639	4139	6700	79	41	157	157	11
281F	20	35	7	4101	6629			79		123	123	11
306F	20	33	8	4057	6635	4140	6718	100	54	161	161	11
4F	20	34	7	4101	6639	4133	6722	81	45	117		31
6F	20	33	7	4057	6635	4133	6722	82	50	182		31
338F	20	33	9	4057	6635	4130	6709	138	42	112		14
5F	20	34	4	4101	6639	CORS		350		147	147	11
7F	20	33	5	4057	6635			368		112	112	14
506F	20	33	4	4057	6635			348		162		14
578F	20	33	10	4057	6635	4058	6830	519	87	128		11
9F	20	34	10	4101	6639	4127	6708	517	34	188		11
611F	20	34	7	4101	6639	4131	6701	436	34	158		14
697F	20	33	6	4057	6635	3958	6926	761	143	136		34
5F	20	33	1	4057	6635	4035	6655	995	27	135	147	14
8M	20	33	5	4057	6635			12		163	163	
149M	20	34	5	4101	6639	4113	6615	23	22	134	134	
0M	20	33	5	4057	6635	4113	6615	23	22	139	139	
0M	20	35	6	4101	6629	4132	6649	43	35	177	177	
202M	20	33	6	4057	6635	4100	6628	44	6	195	195	
206M	20	33	6	4057	6635	4103	6625	48	9	171		
0M	20	34	6	4101	6639	4103	6625	48	10	141		
7M	20	34	6	4101	6639	4053	6639	51	8	125	125	
229M	20	33	6	4057	6635	4053	6639	52	6	136	136	
5M	20	35	8	4101	6629	4140	6705	94	48	176	176	
1M	20	34	10	4101	6639	4109	6707	157	23	156		
479M	20	33	4	4057	6635	4029	6711	329	40	148	148	
558M	20	34	7	4101	6639	4135	6652	429	35	146	170	
5M	20	34	6	4101	6639			773		109		
897M	20	33	4	4057	6635	4119	6616	1075	27	159		

Appendix Table 21

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
185F	21	36	6	4032	6748	4042	6657	7	40	132	132
186F	21	36	6	4032	6748	4010	6850	9	53	103	103
262F	21	36	7	4032	6748	4137	6654	44	76	120	120
399F	21	36	11	4032	6748	4020	6934	167	82	122	122
463F	21	36	4	4032	6748	4028	6710	308	29	170	170
502F	21	36	5	4032	6748	4035	6737	337	9	92	106
592F	21	36		4032	6748	HYDR	WELK			106	
187M	21	36	6	4032	6748			9		103	103
203M	21	36	6	4032	6748	4031	6744	16	2	157	
204M	21	36	6	4032	6748	4031	6744	16	2	101	
205M	21	36	6	4032	6748	4031	6744	16	2	98	
230M	21	36	6	4032	6748	4026	6733	22	12	112	112
231M	21	36	6	4032	6748	4026	6733	22	12	114	114
352M	21	36	10	4032	6748	4110	6901	117	67	117	
493M	21	36	3	4032	6748	4032	6705	295	32	126	
581M	21	36	9	4032	6748			478		171	183
593M	21	36		4032	6748	HYDR	WELK			117	
594M	21	36		4032	6748	HYDR	WELK			93	
595M	21	36		4032	6748	HYDR	WELK			122	
630M	21	36	10	4032	6748	HYDR		482		122	143
745M	21	36	10	4032	6748	4033	6742	859	5	189	
851M	21	36	11	4032	6748	4055	6810	885	28	133	160
861M	21	36	12	4032	6748	OCEA		917		105	125

Appendix Table 22

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
177F	22	38	6	4117	6633	4117	6639		4	177	177	11
8F	22	37	6	4108	6638	4117	6639	2	9	136	136	55
9F	22	37	6	4108	6638	4107	6636	4	2	164		11
208F	22	37	6	4108	6638	4103	6625	13	10	102		11
236F	22	38	7	4117	6633	4141	6704	20	33	141	141	11
7F	22	37	6	4108	6638	4024	6817	20	87	149	149	55
238F	22	37	7	4108	6638	4137	6654	21	32	157	157	11
251F	22	37	7	4108	6638	4136	6653	32	32	138	138	55
0F	22	37	7	4108	6638	4140	6702	38	37	117		54
0F	22	37	7	4108	6638			22		132		14
284F	22	38	8	4117	6633	4142	6659	60	32	134	134	31
7F	22	37	8	4108	6638	4140	6705	59	38	144	144	31
8F	22	37	8	4108	6638	4139	6700	59	38	122	122	11
293F	22	37	8	4108	6638	4140	6704	60	38	157	157	31
307F	22	37	8	4108	6638	4133	6732	72	48	114	114	31
8F	22	37	8	4108	6638	4133	6732	72	48	127	127	31
309F	22	37	8	4108	6638	4133	6732	72	48	101	101	11
316F	22	37	7	4108	6638	4133	6722	48	41	126		31
6F	22	37	9	4108	6638	4129	6727	89	42	124	137	32
7F	22	37	9	4108	6638	4129	6727	89	42	142	142	11
339F	22	37	9	4108	6638	4136	6723	86	44	133	133	11
2F	22	38	1	4117	6633			218		164	164	31
5F	22	37	8	4108	6638	4152	6956	431	155	122		51
597F	22	37		4108	6638	HYDR	WELK			139		14
600F	22	38	8	4117	6633	4138	6651	427	25	151	162	51
6F	22	38	9	4117	6633			451		150		54
70F	22	38	7	4117	6633	4115	6850	750	103	127	140	14
787F	22	37		4108	6638					172		14
22M	22	38	7	4117	6633	4134	6651	23	22	170	170	
242M	22	37	7	4108	6638	4139	6659	25	35	128	159	
43M	22	37	7	4108	6638	4142	6704	28	40	139	139	
48M	22	37	7	4108	6638	4141	6709	31	41	130	130	
258M	22	38	7	4117	6633	4140	6702	37	32	143	143	
261M	22	37	7	4108	6638	4138	6700	41	35	157	157	
78M	22	38	7	4117	6633	4139	6700	45	30	166	166	
303M	22	37	8	4108	6638	4011	6902	76	123	154	154	
305M	22	38	8	4117	6633			62		148	148	
10M	22	37	8	4108	6638	4144	6654	67	38	170	170	
41M	22	38	9	4117	6633	4140	6702	89	32	132		
342M	22	38	9	4117	6633	4140	6702	89	32	156		
54M	22	37	10	4108	6638	4112	6716	126	29	95	95	
78M	22	37	11	4108	6638	4110	6722	167	33	162	186	
652M	22	37	1	4108	6638					195		
722M	22	38	6	4117	6633	4048	6644	737	29	148	163	
47M	22	38	10	4117	6633	4025	6958	865	164	154		
898M	22	37	4	4108	6638	4105	6625	1034	11	121	168	

Appendix Table 23

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
565F	23	50	6	4018	6823	4022	6821	8	5	97	97
567F	23	48	6	4015	6827	4022	6821	9	8	118	118
576F	23	48	8	4015	6827	4050	6917	48	52	122	122
584F	23	48	9	4015	6827	4053	6841	84	39	85	97
646F	23	48	1	4015	6827	4010	6823	205	7	116	127
650F	23	48	1	4015	6827	4007	6904	198	29	111	
651F	23	48	1	4015	6827	4007	6904	198	29	110	
661F	23	48	3	4015	6827	4015	6809	266	15	88	101
662F	23	50	3	4018	6823	4015	6809	266	12	102	112
670F	23	48	5	4015	6827	4029	6742	337	37	90	103
672F	23	50	5	4018	6823	4011	6818	326	8	96	96
675F	23	48	4	4015	6827			311		90	104
728F	23	48	6	4015	6827	4011	7113	348	126	116	116
737F	23	48	7	4015	6827	4040	6810	377	28	110	
739F	23	48	8	4015	6827	4026	6810	408	17	115	
771F	23	48	6	4015	6827	4106	6847	361	54	88	102
775F	23	50	7	4018	6823	4040	6810	376	24	101	
788F	23	50		4018	6823					103	
842F	23	48	11	4015	6827	VEAT	HYDR	511		124	140
848F	23	50	11	4018	6823	4035	6825	506	16	103	
550M	23	48	6	4015	6827	4020	6825	6	6	132	132
556M	23	48	6	4015	6827	4020	6818	8	8	115	
557M	23	48	6	4015	6827	4020	6818	8	8	95	
562M	23	48	7	4015	6827	4035	7009	16	80	86	86
564M	23	50	7	4018	6823	4035	7009	15	83	117	117
659M	23	48	2	4015	6827			241		143	
665M	23	48	4	4015	6827	4006	6849	286	18	114	134
666M	23	48	4	4015	6827	4006	6849	291	18	110	128
736M	23	48	7	4015	6827	4040	6810	377	28	104	
767M	23	48	7	4015	6827	4100	6922	389	62	135	158
769M	23	48	7	4015	6827	4115	6850	377	60	88	102
774M	23	48	7	4015	6827	HYDR		404		90	
789M	23	48		4015	6827					90	
797M	23	48	7	4015	6827	4135	6646	404	112	104	

Appendix Table 24

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
9F	24	49	6	4024	6825	4020	6825	6	6	103	103	55
8F	24	51	6	4027	6815	4020	6818	5	7	102		14
569F	24	51	7	4027	6815	3959	6946	16	74	116		14
580F	24	49	9	4024	6825			100		116	116	54
1F	24	49	10	4024	6825	HYDR		104		81	93	11
6F	24	51	11	4027	6815	4029	6820	149	3	110	123	31
719F	24	51	6	4027	6815	4019	6824	361	11	110	110	14
7F	24	51	5	4027	6815	4026	6809	343	6	90	103	14
5F	24	51	11	4027	6815	HYDR		498		73	73	44
776F	24	51	7	4027	6815	4040	6810	383	14	97		54
738F	24	51	7	4027	6815	HYDR		379		85		44
3F	24	51	11	4027	6815	4017	6833	512	18	98		11
936F	24	51	7	4027	6815			766		157	163	14
947F	24	51	8	4027	6815			781		145		54
566M	24	51	6	4027	6815	4022	6820	6	7	98	98	
5M	24	49	11	4024	6825	4029	6820	152	8	111	129	
7M	24	49	11	4024	6825	4029	6820	152	8	107	107	
548M	24	51	1	4027	6815	4017	7113	207	136	136	136	
553M	24	49	1	4024	6825	4016	6809	220	16	99	115	
6M	24	49	10	4024	6825	4033	6742	481	34	95		
3M	24	51	7	4027	6815	HYDR		383		107		
777M	24	51	7	4027	6815	4040	6810	383	14	123		

Appendix Table 25

T	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
8F	25	57	2	4002	7115	3959	7119	38	5	82		14
735F	25	58	6	3958	7110	3958	7110	169		109		11
1F	25	58	8	3958	7110	4010	7107	209	12	108	108	44
8F	25	58	6	3958	7110	4007	7000	163	54	113		31
927F	25	57	6	4002	7115	4012	7040	412	29	76	90	14
8F	25	57	6	4002	7115	4012	7040	412	29	75	92	14
734M	25	58	7	3958	7110	3958	7110	184		90		
2M	25	58	8	3958	7110	4008	7056	210	15	107		
0M	25	57	6	4002	7115	4002	7119	530	4	104	125	
921M	25	57	6	4002	7115	4005	7118	524	5	83		

Appendix Table 26

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
674M	26	59	5	3914	7220			112		103	103

Appendix Table 27

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
740F	27	62	9	3756	7356	3835	7440	227	52	125	
914F	27	60	6	3754	7402	3744	7409	494	12	124	
915F	27	60	7	3754	7402	3813	7348	526	22	141	
916F	27	60	7	3754	7402	3813	7348	526	22	129	
917F	27	61	9	3755	7358	3900	7434	230	71	98	
935F	27	60	4	3754	7402	3800	7355	448	9	150	
880M	27	60	1	3754	7402	3813	7357	329	20	121	
911M	27	60	7	3754	7402	3813	7348	526	22	72	
912M	27	62	7	3756	7356	3752	7407	516	8	97	
913M	27	60	7	3754	7402	3813	7348	536	22	130	
954M	27	62	10	3756	7356	3800	7355	620	4	101	

Appendix Table 28

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
906F	28	64	6	3910	7239	3902	7242	479	9	123	
663M	28	64	3	3910	7239	3906	7243	36	7	161	161
664M	28	64	3	3910	7239	3906	7243	36	7	146	146

Appendix Table 29

	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
82F	29	66	6	4002	6932	4002	6932	28		76		11
F	29	66	6	4002	6932	4002	6932	28		95	95	33
3F	29	65	6	3958	6926	3958	6926	30		100	100	33
86F	29	66	6	4002	6932	4002	6932	28		87	87	33
F	29	65	6	3958	6926	3958	6926	30		81		14
F	29	66	6	4002	6932	4002	6932	28		76		14
90F	29	65	6	3958	6926	3958	6926	30		73		14
1F	29	65	6	3958	6926	3958	6926	30		78		14
F	29	65	6	3958	6926	3958	6926	30		66		11
98F	29	66	6	4002	6932	4002	6932	28		77		14
99F	29	66	6	4002	6932	4002	6932	31		76		14
F	29	65	6	3958	6926	4000	6923	44	3	80	95	14
2F	29	66	6	4002	6932	4000	6923	42	7	103		34
03F	29	65	6	3958	6926	4000	6923	44	3	76		14
F	29	65	6	3958	6926	4000	6923	44	3	71		11
F	29	65	6	3958	6926	4000	6923	44	3	74		14
12F	29	66	6	4002	6932	4000	6932	42	7	76		14
21F	29	65	6	3958	6926	4048	6924	49	50	108	108	33
3F	29	65	7	3958	6926	4048	6924	53	38	102		33
43F	29	65	7	3958	6926			80		92		14
50F	29	65	8	3958	6926	HYDR		108		117	117	34
1F	29	65	8	3958	6926	HYDR		108		72	72	14
2F	29	65	8	3958	6926	HYDR		108		72	86	14
53F	29	65	8	3958	6926	HYDR		108		84	105	34
5F	29	65	8	3958	6926	HYDR		108		68	82	14
0F	29	66	10	4002	6932	HYDR		152		78	78	14
61F	29	65	10	3958	6926	HYDR		154		76	92	14
63F	29	65	11	3958	6926	HYDR		178		104	115	34
4F	29	65	11	3958	6926	HYDR		178		77	90	14
3F	29	65	7	3958	6926	4035	6910	79	39	81	91	14
80F	29	65	11	3958	6926			185		75	90	14
1F	29	65	11	3958	6926			186		74	87	14
2F	29	65	11	3958	6926	HYDR		184		101	116	14
83F	29	65	11	3958	6926	HYDR		184		116	130	14
0F	29	65	8	3958	6926			96		93	93	14
3F	29	65	8	3958	6926	VEAT		87		105	105	14
94F	29	66	8	4002	6932	VEAT		85		70	85	14
95F	29	65	8	3958	6926	VEAT		87		114	114	14
6F	29	65	8	3958	6926	VEAT		87		117	117	31
5F	29	65	9	3958	6926			130		75	88	11
07F	29	65	9	3958	6926	VEAT	HYDR	130		99	114	31
8F	29	65	9	3958	6926	VEAT	HYDR	130		72	85	11
9F	29	66	9	4002	6932	VEAT	HYDR	128		85	100	31
10F	29	66	9	4002	6932	VEAT	HYDR	128		75	90	14
11F	29	65	9	3958	6926	VEAT	HYDR	130		104	116	31
3F	29	65	9	3958	6926	VEAT	HYDR	130		72	88	14
14F	29	65	9	3958	6926	VEAT	HYDR	130		102	115	31
15F	29	65	9	3958	6926	VEAT	HYDR	130		105	122	31
6F	29	65	9	3958	6926	VEAT	HYDR	130		76	93	11
7F	29	65	9	3958	6926	VEAT	HYDR	130		72	87	14

Appendix Table 29 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	E
818F	29	65	9	3958	6926	VEAT	HYDR	130		77	95	1
820F	29	65	9	3958	6926	VEAT	HYDR	130		71	86	1
821F	29	65	9	3958	6926	VEAT	HYDR	130		70	85	14
822F	29	65	9	3958	6926	VEAT	HYDR	130		73	87	14
826F	29	65	11	3958	6926	HYDR		196		81	95	1
827F	29	65	11	3958	6926	HYDR		196		106	115	3
829F	29	65	11	3958	6926	VEAT		181		96		34
830F	29	65	11	3958	6926	VEAT		181		75		1
832F	29	65	11	3958	6926	VEAT	HYDR	188		72	88	1
833F	29	65	11	3958	6926	VEAT	HYDR	188		73	90	14
835F	29	65	11	3958	6926	VEAT	HYDR	188		77	91	31
837F	29	66	11	4002	6932	VEAT	HYDR	186		87	98	3
838F	29	66	11	4002	6932	VEAT	HYDR	186		103	116	31
839F	29	65	11	3958	6926	VEAT	HYDR	188		74	87	14
840F	29	65	11	3958	6926	VEAT	HYDR	188		99	109	3
841F	29	65	11	3958	6926	VEAT	HYDR	188		113	125	3
844F	29	65	11	3958	6926	VEAT	HYDR	188		71	86	14
845F	29	66	11	4002	6932	VEAT	HYDR	186		94	107	3
846F	29	65	11	3958	6926	VEAT	HYDR	188		99	112	3
847F	29	65	11	3958	6926	VEAT	HYDR	188		95	108	31
850F	29	65	11	3958	6926	4025	6855	178	35	87	104	31
853F	29	65	10	3958	6926	OCEA		173		93	104	3
855F	29	65	11	3958	6926	HYDR		204		87	100	31
858F	29	65	11	3958	6926	OCEA		200		78	90	11
859F	29	65	12	3958	6926	HYDR		211		102	115	3
862F	29	65	12	3958	6926	OCEA		211		91	105	1
867F	29	65	12	3958	6926	4005	6925	213	7	92		34
871F	29	65	12	3958	6926	4005	6925	213	7	71		1
872F	29	65	12	3958	6926	4005	6925	213	7	113		3
874F	29	65	12	3958	6926			221		77	93	14
876F	29	65	12	3958	6926	VEAT	HYDR	210		100	115	34
878F	29	65	12	3958	6926	VEAT	HYDR	210		103	116	3
881F	29	66	11	4002	6932	4017	6833	190	47	67		1
882F	29	65	11	3958	6926	4017	6833	192	45	72		14
886F	29	65	1	3958	6926	HYDR	WELK	242		70	83	1
888F	29	65	1	3958	6926	HYDR	WELK	242		76	91	1
889F	29	65	1	3958	6926	HYDR	WELK	242		74	86	14
890F	29	65	1	3958	6926	3955	6935	250	8	114	130	3
902F	29	66	2	4002	6932	HYDR		267		98		1
907F	29	65	6	3958	6926	3955	6935	396	8	104	118	1
910F	29	65	7	3958	6926	VEAT		428		80	93	14
919F	29	65	6	3958	6926			407		77		1
922F	29	65	6	3958	6926	4005	6900	416	21	92		1
923F	29	66	6	4002	6932	4005	6900	414	25	94		34
924F	29	65	6	3958	6926	4005	6900	416	21	95		3
926F	29	65	6	3958	6926	4012	7040	414	58	81	97	1
929F	29	65	7	3958	6926	4005	7020	428	42	78	90	14
930F	29	65	7	3958	6926	4005	6945	438	16	75	89	1
931F	29	65	7	3958	6926	4005	6945	432	16	78	108	1
941F	29	65	10	3958	6926	HYDR		532		72	100	1

Appendix Table 29 Cont.

ET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2	EC
48F	29	65	7	4001	6930	HYDR		420		110		34
F	29	65	7	4001	6930	HYDR		429		69		14
F	29	66	7	4002	6932	HYDR		421		101		34
51F	29	65	6	4001	6930	HYDR		419		117		34
3F	29	65	9	4001	6930	4005	6908	492	18	63		14
80M	29	66	6	4002	6932	4002	6932	28		74		
1M	29	65	6	3958	6926	3958	6926	30		72		
M	29	65	6	3958	6926	3958	6926	30		77		
88M	29	66	6	4002	6932	4002	6932	28		77		
92M	29	65	6	3958	6926	3958	6926	30		80		
M	29	65	6	3958	6926	3958	6926	30		79		
M	29	65	6	3958	6926	3958	6926	30		79		
00M	29	65	6	3958	6926	4000	6923	44	3	80		
M	29	65	6	3958	6926	4000	6923	44	3	72		
M	29	65	6	3958	6926	4000	6923	44	3	78		
07M	29	65	6	3958	6926	4000	6923	44	3	78		
8M	29	65	6	3958	6926	4000	6923	44	3	69		
M	29	65	6	3958	6926	4000	6923	44	3	74		
11M	29	66	6	4002	6932	4000	6923	42	7	79		
54M	29	65	8	3958	6926	HYDR		108		74	90	
M	29	65	8	3958	6926	4125	7056	108	111	76	91	
M	29	65	7	3958	6926	HYDR		81		72		
06M	29	65	9	3958	6926	VEAT	HYDR	130		80	98	
2M	29	65	9	3958	6926	VEAT	HYDR	130		77	95	
M	29	65	9	3958	6926	VEAT	HYDR	130		80	95	
23M	29	65	9	3958	6926	VEAT	HYDR	130		75	94	
24M	29	65	9	3958	6926	VEAT	HYDR	130		77	94	
M	29	65	11	3958	6926	VEAT		181		78		
1M	29	65	11	3958	6926			188		70	85	
34M	29	65	11	3958	6926	VEAT	HYDR	188		78	95	
M	29	65	11	3958	6926	VEAT	HYDR	188		81	98	
3M	29	65	11	3958	6926	VEAT	HYDR	188		80	96	
54M	29	66	11	4002	6932	HYDR		202		73	89	
0M	29	65	11	3958	6926	HYDR		186		74		
4M	29	65	12	3958	6926	4005	6925	213	7	66		
65M	29	65	12	3958	6926	4005	6925	213	7	81		
66M	29	65	12	3958	6926	4005	6925	213	7	68		
8M	29	65	12	3958	6926	4005	6925	213	7	70		
9M	29	65	12	3958	6926	4005	6925	213	7	74		
73M	29	65	12	3958	6926	4005	6925	213	7	72		
7M	29	66	12	4002	6932	VEAT	HYDR	208		70	86	
7M	29	65	1	3958	6926	HYDR	WELK	242		78	91	
95M	29	65	12	3958	6926	3955	7135	221	102	81		
6M	29	65		3958	6926	HYDR				72		
M	29	65	4	3958	6926	3958	6950	354	18	83	101	
00M	29	65	3	3958	6926	4025	6955	308	35	77	94	

Appendix Table 29 Cont.

RET	CS	OS	MO	RLAT	RLON	CLAT	CLON	DATL	MIL	CL1	CL2
901M	29	65	2	3958	6926	HYDR		269		77	92
903M	29	65	2	3958	6926	HYDR		269		71	
904M	29	65	11	3958	6926	OCEA		193		71	
909M	29	65	5	3958	6926	4005	7025	361	46	78	96
925M	29	65	6	3958	6926	4010	6905	417	20	68	80
939M	29	65	8	3958	6926	4010	6940	465	16	69	
942M	29	65	10	3958	6926	HYDR		532		74	110
945M	29	65	9	3958	6926			496		80	101
952M	29	65	7	4001	6930	HYDR		442		69	

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977—796-650/#4 REGION 10

NOAA Technical Report NMFS SSRF -706

Food of Western North Atlantic Tunas (*Thunnus*) and Lancetfishes (*Alepisaurus*)

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January 1977

U.S. DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary
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Food of Western North Atlantic Tunas (*Thunnus*) and Lancetfishes (*Alepisaurus*)

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ABSTRACT

Stomach contents of 395 longline-caught specimens of *Thunnus* (281 *T. albacares*, 52 *T. t. thynnus*, 48 *T. alalunga*, 14 *T. obesus*) and 89 *Alepisaurus* were examined. About 45% of the tuna's food, by volume, was composed of fishes, 35% of cephalopods, 15% of crustaceans, and 5% of miscellaneous items. Fishes eaten by tunas ranged in length 9-360 mm SL ($\bar{x}$ 65 mm) and represented a minimum of 88 genera in 58 families. Fishes eaten by *Alepisaurus* were 8-846 mm SL ($\bar{x}$ 98 mm) and represented 40 genera in 34 families. Most forage fishes were immature forms of midwater and shore fishes, many of which are associates of the pelagic *Sargassum* community. Ten of the most frequently occurring families in *Thunnus* and *Alepisaurus* stomachs were Bramidae, Alepisauridae, Balistidae, Paralepididae, Scombridae, Sternoptychidae, Carangidae, Tetraodontidae, Gempylidae, and Syngnathidae.

Cephalopods were the most frequently occurring (80-90%) invertebrate group in the tuna stomachs, particularly the squid family Ommastrephidae. Crustaceans followed the cephalopods in frequency of occurrence (30-80% depending on tuna species). Larval decapods and hyperiid amphipods were the principal groups of crustaceans. In *Alepisaurus* stomachs, cephalopods occurred with 50% frequency, usually octopods and soft-bodied squids, families Cranchiidae, Histioteuthidae, and Bathyteuthidae. Crustaceans were present in 75% of *Alepisaurus* stomachs. Fewer decapod larvae were found than in the tunas, while amphipods were found more frequently. Pelagic polychaetes (Family Alciopidae), not found in any tunas, occurred in 38% of *Alepisaurus* specimens.

Differences in the relative importance of particular forage categories in the diet of different species of *Thunnus* and between the diets of *Thunnus* and *Alepisaurus* suggest interspecific differences in feeding, either anatomical (i.e., relative predatory ability) or behavioral, particularly the relative swimming speeds and feeding depths of different predators. The small-mouthed tunas consumed generally smaller prey fishes ($\bar{x}$ 98 mm SL) than did the large-mouthed lancetfishes ($\bar{x}$ 240 mm SL). Smaller sized yellowfin tunas generally consumed smaller prey than did larger yellowfins. Differences in swimming ability between tunas and *Alepisaurus* were reflected in the larger number of swift-moving muscular squids eaten by the tunas. Composition of the forage indicated that *T. albacares* fed at shallower depths than the other species of *Thunnus* and that *Alepisaurus* fed at greater depths than any of the tunas.

INTRODUCTION

the past 20 yr, the tunas have become objects of ified commercial and recreational fisheries. Heavy ization of these fishes and subsequent concern about limitation of stocks have made an understanding of biology increasingly important. Because the tunas ak predators in a vast part of the epipelagic zone, important aspect of investigation is their feeding its. Numerous forage studies have been carried out in ts of the world for the tunas of the genus *Thunnus* e skipjack genus *Katsuwonus*. Most information been reported on a qualitative basis, however, and studies have been based upon small samples. For the Atlantic Ocean, Dragovich (1969) reviewed the important literature on tuna feeding habits published until that time. Since then, several important contributions have been added for the Atlantic: Dragovich reported on the food of skipjack and yellowfin tuna in the Atlantic (1970a) and the bluefin tuna in the eastern tropical Atlantic (1970b); Dragovich and Potthoff (1972) compared the food of the yellowfin and skipjack off the coast of West Africa, and Borodulina (1974) reported on the feeding of bigeye tuna in the Gulf of Guinea.

Literature on Pacific tunas has not been similarly summarized. Important contributions include investigations on the feeding of yellowfin in the central Pacific (Reintjes and King 1953) and the comparison of the food of central Pacific bigeye and yellowfin (King and Ikehara 1956). Alverson (1963) compared the forage of yellowfin and skipjack in the eastern tropical Pacific. Iversen (1962) studied the food habits of albacore in the central and northeastern Pacific. Iversen (1971) reported on albacore and Pinkas (1971) reported on bluefin feeding habits in Californian waters.

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In the present study, we examined the stomach contents of four species of *Thunnus* in the western North Atlantic: *T. albacares* (Bonnaterre), the yellowfin; *T. alalunga* (Bonnaterre), the albacore; *T. t. thynnus* (Linnaeus), the Atlantic bluefin; and *T. obesus* (Lowe), the bigeye. The specimens examined were obtained during a series of exploratory longline cruises over the period 1957-64 by the Bureau of Commercial Fisheries (now National Marine Fisheries Service) MV *Delaware*, before a major fishery was established in the region. While fishing for tunas, lancetfishes of the genus *Alepisaurus* were often hooked by the longline. In this capacity at least, the lancetfishes were competing with tunas; being thus an apparent competitor, it seemed worthwhile to examine also the stomach contents of *Alepisaurus* taken with *Thunnus*. *Alepisaurus* forage has previously been investigated in the Atlantic by Haedrich (1964). Parin et al. (1967) reported on the feeding habits of *Alepisaurus* in the Indian Ocean. In the Pacific, lancetfish feeding habits have been reported on by Haedrich and Nielsen (1966), Kubota and Uyeno (1969), Rancurel (1970), and Kubota (1973).

Included in the present study are both species of lancetfishes, *Alepisaurus ferox* Lowe and *A. brevirostris* Gibbs. No distinction is made between species, however, because much of the data were collected before the latter was described by Gibbs (1960).

MATERIALS AND METHODS

We examined the contents of 395 *Thunnus* stomachs (281 *T. albacares*, 52 *T. t. thynnus*, 48 *T. alalunga*, and 14 *T. obesus*) and those of 89 *Alepisaurus*. Number, size range, and mean size of the *Thunnus* and *Alepisaurus* specimens are presented in Table 1. All specimens were collected by longline from the western North Atlantic off the eastern coast of the United States north of Bermuda and, on one cruise, east to the Azores (Figure Specimens were taken from depths of 10-60 m. Long gear and methods used were described by Squire (1 and Wilson and Bartlett (1967).

Most of the *Thunnus* stomach contents were collec by Robert H. Gibbs, Jr. and Bruce B. Collette in junction with a study of the anatomy and systemati the genus *Thunnus* (Gibbs and Collette 1967). Meth to obtain stomach contents were used that would damage the tuna specimens. The stomach conten *Thunnus* were obtained through a longitudinal ve incision through which the stomach was pulled, the c tents were removed, and the emptied stomach pus back into place. As a result, the total contents were always obtained. The stomach contents that collected for each specimen were preserved in 10% malin. Size (mm fork length (FL)) and weight of tuna were usually recorded.

Alepisaurus stomach contents were obtained by s ing the specimen head-down over a bucket, after removal from the longline hook. The lancetfish's mouth, esophagus, and stomach allowed its ston contents to fall out readily into the collection buc Contents were then preserved in 10% Formalin.

Some stomach contents were identified at sea, re ed, and discarded; others were identified at the W Hole Oceanographic Institution and Boston Univer

Table 1.—Numbers, size ranges, and mean sizes of *Thunnus* sp *Alepisaurus* examined.

	N	Size range (cm FL)	
Thunnus albacares	281	74-166	11
Thunnus alalunga	48	96-106	10
Thunnus thynnus	52	158-232	1
Thunnus obesus	14	142-165	1
Alepisaurus sp.	89	48-138	–

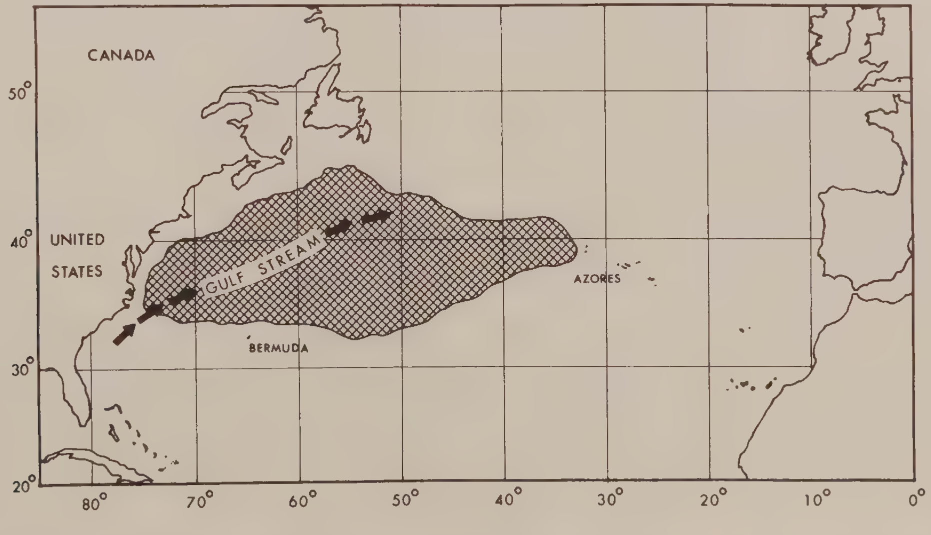


Figure 1.—Area sampled (crosshatched) for *Thunnus* and *Alepisaurus* by longline in the western North Atlantic.

eteropods and pteropods from this collection were ed and reported on by Russell (1960). The bulk of aterial was then transferred to the National Marine sheries Service Systematics Laboratory at the U.S. ational Museum of Natural History. To facilitate iden- ion, the stomach contents were divided into broad ories: fishes, cephalopods, other mollusks, ustaceans, jellyfish, and miscellaneous. D. M. amkaer identified the crustaceans and, under the nce of Clyde Roper (a specialist in cephalopod tax-), the cephalopods and the remainder of the invertebrates. Leslie Knapp (Smithsonian Oceanographic g Center (SOSC)) supervised the identification of hes with the assistance of several specialists on the list. Representative specimens of forage species in od or fair condition have been deposited in the relevant ions of the National Museum of Natural History s, mollusks, crustaceans, and fishes).

The identification of forage specimens depended on e degree to which digestion had damaged the organism n its stage of maturity, particularly in the eans and cephalopods. Fishes were more completely identified than were other groups, usually to and often to species. A large portion of the in- ate forage could be identified only to order or mily. Therefore, the number of taxa from any one tegory of forage organisms, while giving a picture of the ty of forage, should not be considered quan- ly.

The relative importance of a forage category can conniently be thought of in terms of the amount of energy ds its predator, measured by number and size of a lar organism eaten. The frequency with which an ganism is eaten, furthermore, often gives a rough es- of its general availability to a predator. To te the composition of forage, therefore, we used hree measurements: 1) Frequency was calculated percent frequency of occurrence, e.g., in what percent- the total number of stomachs examined a par- organism was found. 2) The number of inviduals per stomach from a particular forage group was mpared numerically. 3) The size of a forage organism pressed as length: crustaceans as mm total length, pods as mm mantle length, and fishes as mm andard length (SL, tip of snout to the base of the udal fin). Accuracy of measurement was dependent he degree to which the forage specimen had been d; approximations were often made in cases where eletons were incomplete, but suggestive of the m's full size.

onsidered a forage organism to be of greatest im- rtance when it was eaten with relatively high frequen- , was comparatively larger than other forage organisms and was consumed by an individual predator in numbers than the mean number of other forage oups present in that stomach. The less important a rage organism appeared in these three aspects, relative other organisms eaten, the less important it was red to the predator's diet. No statistical tests re applied.

RESULTS

Taxonomic lists of forage components of *Thunnus* and *Alepisaurus* are presented in Appendix Table 1. Forage organisms which are additions to taxa listed for the Atlantic Ocean by Dragovich (1969) for *Thunnus* or by Haedrich (1964) for *Alepisaurus* are noted. Fishes, crustaceans, and mollusks made up the bulk of the collection. Medusae, salps, *Sargassum*, and parasitic nematodes and trematodes, which are not included in the forage lists, were also present. The forage composition for all *Thunnus* species consisted of, by volume, about 45% fishes, 35% cephalopods, 15% crustaceans, and 5% miscellaneous items.

Vertebrate Forage (Fishes)

Fishes occurred with a frequency of 66-100%, depending on the species of predator. Those consumed by tunas ranged in length 9-360 mm SL ($\bar{x}$ 65 mm) and represented 88 genera in 58 families. Fishes eaten by *Alepisaurus* varied over a greater size range (8-846 mm SL, $\bar{x}$ 98 mm) and represented 40 genera in 34 families. The majority of forage fishes in *Thunnus* and *Alepisaurus* were immature forms of midwater fishes and epipelagic post-larvae and juveniles of shore fishes.

Fish were present in 95% (266 stomachs) of the *T. albacares* stomachs examined. Evaluation of fish forage composition is based on 209 stomachs, however, in which fishes were identifiable. Of the 48 *T. alalunga* examined, 79% (38 stomachs) contained fish. Evaluation is based on 14 stomachs containing identifiable specimens. Seventy-three percent (38 stomachs) of the *T. thynnus* consumed fish. Forage composition analysis is based on 24 stomachs containing identifiable specimens. Forage fish were present in all 14 of *T. obesus* examined, but could be identified further in only eight.

The contents of *Alepisaurus* stomachs were generally in better condition than those from the tunas. Ninety-one percent (81 stomachs) of the *Alepisaurus* specimens examined had consumed fish, most of which were identifiable at least to family. The percent identifiable from *Alepisaurus* stomachs may be larger than from tunas because identification was easier, perhaps because digestion in *Alepisaurus* takes place mainly in the intestine, the stomach being used only for storage (Rofen 1966).

***Thunnus albacares*.**—Forty families of fishes were found in the stomachs of yellowfin (Appendix Table 2). Those which occurred with at least 1% frequency are included in Figure 2.

Ten families occurred with 10% frequency or more: Balistidae, 41%; Carangidae, 31%; Bramidae, 24%; Chiasmodontidae, 21%; Syngnathidae, 18%; Priacanthidae, 13%; Tetraodontidae, 13%; Holocentridae, 12%; Acanthuridae, 11%; and Scombridae, 10%. Except for the Scombridae, none was outstanding in either size or number. In most families, one genus or one species was chiefly responsible for its high frequency: *Monacanthus* spp., *Caranx* sp., *Pterycombus* sp.,

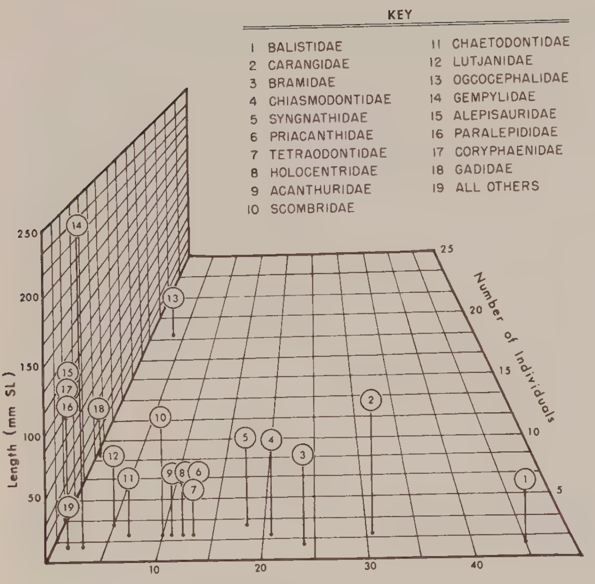


Figure 2.—Relative importance of families of fishes present in more than 1% of the stomachs of western North Atlantic *Thunnus albacares*. Percent frequency of occurrence is on the horizontal axis, mean length (mm SL) of forage family on the vertical axis, and mean number of individuals in a forage family on the third axis. The most important families are those that occur more frequently (to the right on the horizontal axis), average larger in size (lines coming up from the horizontal axis), and are the most numerous (displaced back into page on third axis).

Pseudoscopelus sp., *Hippocampus erectus*, *Cookeolus boops*, *Sphoeroides* sp., and *Auxis* sp. were of primary importance (Appendix Table 2). The occurrence of 32 *Cookeolus boops* (13-66 mm SL) in 26 stomachs of *T. albacares* is of interest because only 13 specimens of this species have previously been recorded from the western Atlantic (Anderson et al. 1972). One of these was identified by Caldwell (1962) from the stomach of one of the *T. albacares* collected during this study.

Fishes eaten by yellowfin varied in length 11-360 mm SL, $\bar{x}$ 45 mm SL. Gempylids ($\bar{x}$ 216 mm), *Coryphaena* ($\bar{x}$ 141 mm), *Alepisaurus* ($\bar{x}$ 120 mm), paralepidids ($\bar{x}$ 105 mm), and scombrids ($\bar{x}$ 96 mm) were the largest forage fishes. Except for the Scombridae, they were present in only a few stomachs and in small numbers. Ogcocephalidae, although eaten infrequently and among the smallest ($\bar{x}$ 17 mm SL) forage fishes, was the only family to occur in large numbers (43 in one stomach, average 19). No fishes which were eaten in large numbers, or which were outstanding in size, occurred with greater than 6% frequency, except for the Scombridae.

***Thunnus alalunga*.**—Fishes consumed by *T. alalunga* belonged to 21 families (Appendix Table 3). They averaged slightly smaller ($\bar{x}$ 40 mm SL) than fishes eaten by *T. albacares*. Gempylidae and Paralepididae were the most important forage families in terms of size and quency of occurrence. Gempylids consisted most *Diplospinus multistriatus* which was present in 3 the stomachs and was the largest sized group ($\bar{x}$ 151 SL). Paralepididae occurred in 29% of the stomachs averaged 101 mm SL. Bramidae were present in 6 the stomachs examined, but were less important in of size. *Omosudis lowei* was also frequently ea although the family Omosudidae as a whole did no cur frequently. The only group to occur in large nur was Ogcocephalidae, 40 of which were present in a s stomach.

***Thunnus thynnus*.**—The food of *T. thynnus* inc 17 families of fishes (Appendix Table 4). Bramidae (were the most frequently occurring, with *Co* *drachme* and *Taractes* spp. (both present with 8 quency) being chiefly responsible for the high frequ of the whole family. Balistidae (17%) were also consu frequently. *Alepisaurus* sp., *Auxis* sp., and *Hippoca* *erectus* occurred relatively frequently, though th quencies of their families were not particularly hig

The size range of forage fishes was 29-230 mm S single family appeared to be unusually large in although *T. thynnus* forage fishes were larger o average ($\bar{x}$ 107 mm SL) than those eaten by eith *albacares* ($\bar{x}$ 45 mm SL) or *T. alalunga* ($\bar{x}$ 37 mm while they were smaller than those of *T. obesus* mm SL).

***Thunnus obesus*.**—Nine families and six gen fishes were identified from 14 *T. obesus* stom Alepisauridae, Balistidae, Belonidae, Bram Caproidae, Melamphaidae, Nemichthyidae, Par didae, and Trachipteridae. Only two families occu more than one stomach: Paralepididae, in three (37 quency), and Alepisauridae, in two (25% frequency) fishes eaten by *T. obesus* were on the whole large those consumed by the other species of *Thunnus* smallest was 83 mm SL; others ranged up to 34 ($\bar{x}$ 213 mm SL).

***Alepisaurus*.**—Thirty-eight genera of fishes fro families were found in the stomach conten *Alepisaurus* (Appendix Table 5). The five most co families included most of the largest fishes Paralepididae ($\bar{x}$ 124 mm SL) was the most frequ occurring family, present in 53% of the stomachs ex ed. Several *Paralepis coregonoides* measured 6 mm SL. Gempylidae ranked high in both size ($\bar{x}$ 1 SL) and occurrence (27%). Alepisauridae wer largest prey group eaten ($\bar{x}$ 213 mm SL) and were p in 12% of the stomachs. Sternoptychids were pres 27% of the stomachs. They were not outstanding but were often consumed in large numbers—as m 54 in one stomach. Bramidae were present in 11% stomachs, although they were not important in size or number.

nvertebrate Forage

t taxa of invertebrate forage belonged to two , Mollusca and Crustacea (Appendix Table 1). alps and scyphozoan medusae were also present, but not identifiable.

Thunnus.—Cephalopods were the most frequently ocurring invertebrates (80-90%) in the stomachs of all s of *Thunnus* (Appendix Tables 6-8). Crustaceans present in 30-80% of the stomachs, depending on ne species of tuna. In stomachs where the two groups -occurred, the percent-volume ratios of cephalopods: ceans were about 75:25 (range 67-79:21-33). lopods were, furthermore, more often the exclusive ontent of a stomach than were crustaceans (Appendix able 10). Heteropods and pteropods were also abun- more so than indicated in our tables because they emoved from many samples by Russell (1960).

Cephalopods were the largest invertebrates eaten le lengths up to 200 mm). The most voluminous abundant were species of the family Ommastrephidae. *Gonatus fabricii* (Gonatidae) was also ommon. The most common octopods were the species of *auta* (including *A. argo*) and *Alloposus mollis.* e-dwelling *Argonauta* occurred far more often in ne stomachs of *T. albacares* (36%) and *T. thynnus* (25%) an in *T. alalunga* (8%), and was not found in *T. obesus* ndix Table 11). The gelatinous octopod, *Alloposus* , was frequently consumed by *T. thynnus* (48% equency), but rare or absent in the diet of other species as.

n though abundant, pteropods and heteropods are ot as important a component of the forage as are ephalopods and crustaceans because of the small size of mollusks. They occurred in 52% of the *T. thynnus* chs examined (Appendix Table 8). Russell (1960) und the heteropod *Carinaria lamarcki* in *T. albacares* omachs at 14 localities but gave no indication of either umber of heteropods found or the number of chs examined. He reported the pteropod *Cavolina identata* from *T. albacares* stomachs at three localities.

Crustaceans were generally smaller than cephalopods ere usually consumed in larger numbers, par- ly amphipods and larval forms. The number of the yperiid amphipod *Phrosina semilunata* (lengths of 20-) per single stomach sometimes exceeded 100 and uted a considerable portion of the forage volume. *hrosina semilunata* was present in the stomachs of 65% the *T. alalunga*, and in 20-30% of the other tuna s. Although not in large numbers, various species hyperiid genus *Phronima* were also frequently ilized. They were found in 15% of *T. albacares* and *T. ynnus*, and in 9% of *T. alalunga*. Several other species eriid amphipods collectively showed a high fre- y of occurrence (10-20% depending on species of na).

Decapods were the largest crustaceans consumed. Por- , represented by the sargassum crab (*Portunus* when identifiable, were eaten by 11% of *T. albacares*. Brachyuran and anomuran larvae were found in about 10% of *T. albacares* and *T. alalunga*, though rarely present in *T. thynnus* and absent from *T. obesus*. The large penaeid larva *Cerataspis petiti* comprised a significant portion of the crustacean volume in 5% of *T. albacares* stomachs. Scyllarid larvae and juveniles were also consumed by *T. albacares* and *T. alalunga*, although less frequently. Other decapods, mostly larvae, occurred in low frequency when considered separately, but were present in a sizeable percentage of tuna stomachs (about 10-30%) when considered as a group.

Isopods and copepods were not significant in either volume or frequency (1-2%). In one sample, it appeared that copepods had been eaten by another forage organism and were in the tuna stomach only secondarily. Also, the isopod, *Ceratothoa* sp., a parasite of exocoetids, was probably ingested only incidentally, in the capture of its host.

Alepisaurus.—Most of the invertebrates eaten by tunas were also consumed by *Alepisaurus* (Appendix Table 1). Forage composition differed, however, in the relative importance of different taxonomic groups. The percent-volume ratio of cephalopods:crustaceans was roughly 50:50 (Appendix Table 10). Crustaceans outranked cephalopods in frequency, however, in a ratio of 75:50. Deep-dwelling soft-bodied squids (Histioteuthidae, Bathyteuthidae, Cranchiidae; Roper and Young 1975) occurred more often in *Alepisaurus* (15%) than in any of the tunas. Other squids, although eaten less than by tunas, were still common (42%). Octopods were often present in *Alepisaurus* forage, *Argonauta* in 25%, *Alloposus* in 32%, and all others in 32% (Appendix Table 11).

Crustaceans were more often the exclusive content of an *Alepisaurus* stomach than were cephalopods. *Phronima* spp. (51%), other hyperiids (47%) (including two not found in the tunas), and anomuran larvae (22%) occurred in generally higher numbers and with higher frequency than in any of the tunas. No portunids were found in *Alepisaurus*, although two or three unidentified crab larvae were present.

Heteropods and pteropods were present in 14% and 12% of the *Alepisaurus* stomachs that we examined (Appendix Table 9) but the actual occurrence was much higher because Russell (1960) removed these mollusks from many of the *Alepisaurus* stomachs. Russell reported seven species of heteropods from three families and five species of pteropods from two families in his sample of *Alepisaurus* stomachs (Appendix Table 1). The heteropod *Carinaria lamarcki* and four species of the pteropod genus *Cavolina* were found at most stations, but Russell gave no numbers of forage organisms or of stomachs examined.

An important constituent of the *Alepisaurus* diet was the family of pelagic polychaetes, Alciopidae, present in 38% of the stomachs and forming much of the total food bulk. Gelatinous organisms (salps, pyrosomas, medusae, and siphonophores) were also more common in *Alepisaurus* stomachs than in tunas.

DISCUSSION

Planktonic and nektonic organisms comprising the diets of the tunas and lancetfishes ranged widely in size and form, suggesting that these predators feed opportunistically. Other data on the food of tunas show, worldwide, a large degree of consistency in forage composition, probably reflecting their association with a distinctive global epipelagic community (Haedrich and Nielsen 1966; Parin et al. 1969; Brodulina 1974). Fishes were consistently the largest and most frequently occurring taxonomic group and, where volumes were measured, constituted the largest forage volume. Cephalopods generally ranked second to fishes in all three measurements. Other invertebrates were generally much smaller but were often eaten in large numbers, particularly amphipods and larval crustaceans, probably encountered in swarms.

Despite such overall consistency, definite differences in the relative importance of certain forage categories do indicate some degree of feeding selectivity, either anatomical or behavioral. Some interspecific and intraspecific feeding differences can be traced to the anatomy of the predator. The size of the gill raker gap determines the minimum size of prey that can be captured and retained (Magnuson and Heitz 1971) and the maximum prey size is determined by the greatest distensibility of the predator's mouth and esophagus. Indeed, the small-mouthed tunas consumed generally smaller prey (mean forage fish length, 98 mm SL) than did the large-mouthed lancetfishes (mean forage fish length, 240 mm SL) .

A similar trend in forage utilization can be seen within a single tuna species. *Thunnus albacares* were divided into three size groups (60.0-99.9 cm FL, 100.0-119.9 cm FL, and 120.0-169.9 cm FL) to facilitate forage comparison. The largest fishes eaten (Gempylidae, $\bar{x}$ length 216 mm SL; Coryphaenidae, $\bar{x}$ length 141 mm SL; Alepisauridae, $\bar{x}$ length 120 mm SL; Paralepididae, $\bar{x}$ length 105 mm SL; Scombridae, $\bar{x}$ length 96 mm SL) were consumed most frequently by the largest sized tunas; among the prey families only the scombrids appeared in the smallest sized tunas. Conversely, the frequency of occurrence of the smallest forage organisms generally decreased with increasing tuna size, as shown by the overall mean frequency of occurrence for larval decapods in Appendix Table 6 ($\bar{x}$ 12.2% frequency of occurrence in 60.0-99.9 cm FL tunas; $\bar{x}$ 10.3% in 100.0-119.9 cm FL tunas; $\bar{x}$ 3.33% in 120.0-169.9 cm FL tunas). Similar trends were not apparent in the other tuna species (Appendix Tables 7-8).

A second limitation of forage composition is determined by the fish's predatory ability, particularly swimming speed. While the tunas are powerful, efficient swimmers, *Alepisaurus* is comparatively slow; this difference is reflected in the type of organism most frequently consumed. Swift-moving muscular squids (such as *Gonatus* and *Onychoteuthis*; Roper and Young 1975) were eaten much more frequently by tunas than by *Alepisaurus*; both capture squids more efficiently, however, than does the 10-foot Isaacs-Kidd midwa trawl. The predatory ability of tunas is further reflec in the frequency with which they consume such swimming fishes as Belonidae, Scomberesocidae, ocoetidae, Carangidae, and Coryphaenidae. The abse of these families from the *Alepisaurus* stoma however, may be due to the fact that they are found near the surface, where *Alepisaurus* probably does feed, rather than because *Alepisaurus* is unable to ca them.

Differences in depths at which predators feed prob constitute another mode of forage selectivity. In orde compare differences in feeding depth, we divided for components somewhat arbitrarily into three categ according to their position in the water colu *Sargassum*-associates (strictly surface organis associated with pelagic *Sargassum* in the upper 5 water); near-surface (the upper 20 m); and midw (both vertical migrators and those which remai depths).

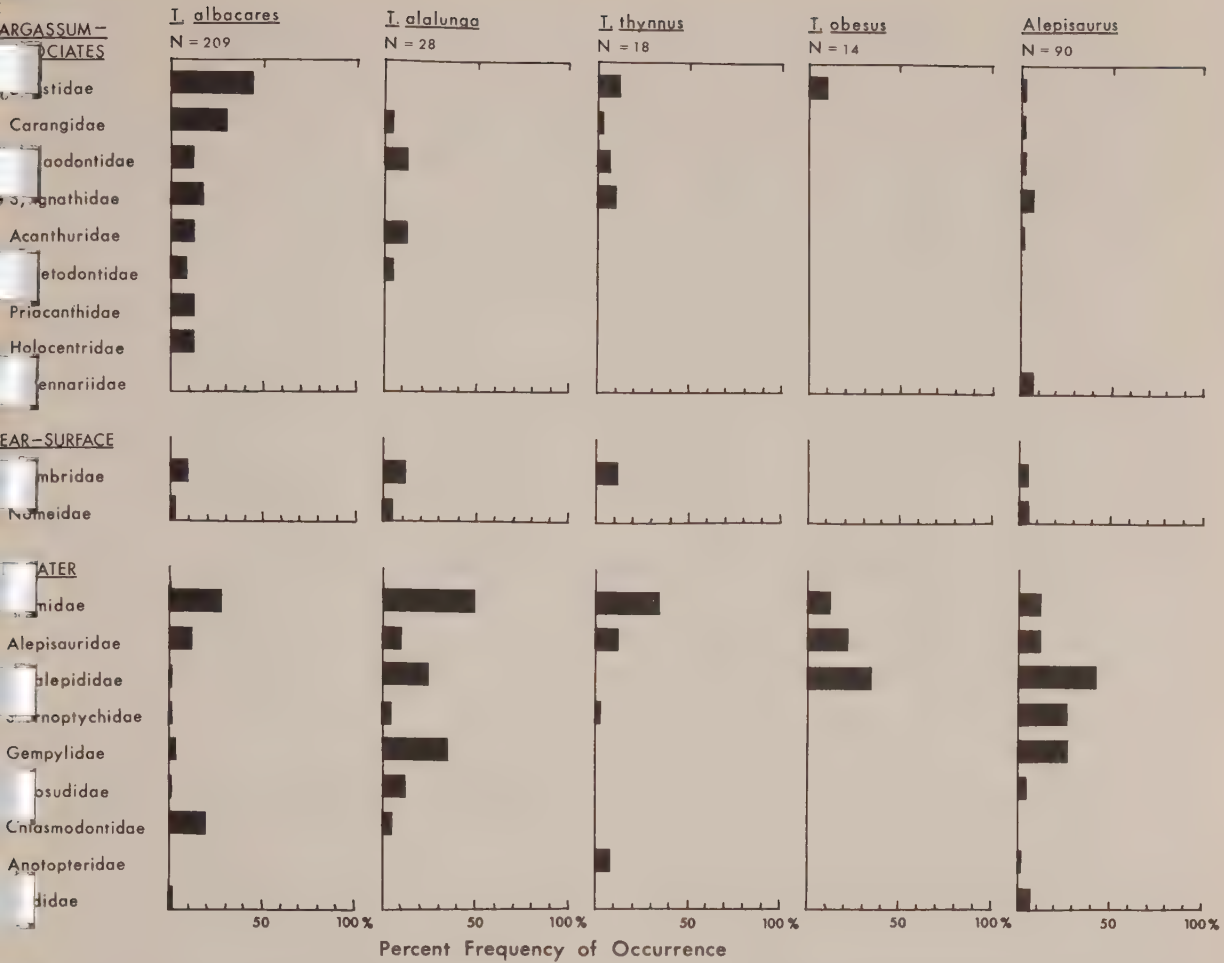
Thunnus albacares evidently fed mainly at the sur particularly on *Sargassum* associates. Bits of *Sarga* present in stomachs were probably accidentally inge in the process of capturing associated fauna, of w *Portunus sayi*, the sargassum crab, and large numbe epipelagic decapod larvae were most frequently sumed (see Fig. 4). The most frequently occurring fi in *T. albacares* stomachs were juveniles of reef and s fishes, also associates of the *Sargassum* communit

The *Sargassum* community plays a similar role i nutrition of other peak oceanic predators such as dolphins *Coryphaena hippurus* and *C. equiselis* (G and Collette 1959). This utilization is reasonable t pect, as the *Sargassum* community provides the concentration of forage organisms in the otherwise ba oceanic surface waters (see Fine 1970; Dooley 197

In contrast with the surface-oriented *T. albacares* diets of *T. alalunga*, *T. thynnus*, and *T. obesus*, posed mainly of midwater organisms, suggest that t tunas feed at somewhat greater depths. Forage positions observed may be incomplete, however, be the samples examined were comparatively small.

The relatively small representation of epipe organisms and high frequency of occurrence of mid fishes and invertebrates in the diet of *Alepisauru* dicates that this predator feeds in the midwater la (Figs. 3, 4). It might be noted in particular *Alepisaurus* consumed the deeper-occurring gelat squids (Histioteuthidae, Bathyteuthidae, Cranchiidae) and the gelatinous octopod, *Allop mollis* (family Alloposidae), much more frequently did any of the tunas (except for *T. thynnus* feedi *Alloposus mollis*). These cephalopods are probably n abundant in the shallower levels, where tunas fee

Relative feeding depths discussed above generally respond to hooking depth records for tunas (Sho and Murphy 1955; Yabe et al. 1963; Osipov 1968; Le and Grandperrin 1973; Saito 1975) and lancetfi *Thunnus albacares* is generally the most sha occurring species; *T. alalunga* and *T. thynnus*



3.—Frequency of occurrence of the 20 most frequently occurring families of fishes in the stomachs of *Thunnus* and *Alepisaurus*. Families are separated into three categories: *Sargassum*-associates, near-surface, and midwater.

what deeper and may have broader depth ranges; *T. obesus* is recognized as the deepest swimming of e tunas. The distribution of the lancetfishes may be far der than that of the tunas, although the lower depth is not established. Large specimens have been ected as shallow as 30 m, while small ones have been aught in open nets fished as deep as 2,000 m (Gibbs and movsky 1966). Rancurel (1970) concluded that their ary feeding area is in the upper 300 m.

The following paragraphs summarize observations on rage composition reported in major studies from both Atlantic and the Pacific for comparison with our . Forage composition in these studies may reflect ifferences in the geographical distributions of prey, cal abundances of forage organisms, or local differences ther predator or prey swimming depths but the taxnic composition of the major food components is milar in all of these studies.

unnus albacares.—Dragovich (1970a) reported on e food of yellowfin from the western North Atlantic. *Auxis* sp. (Scombridae) constituted 26.6% of the food volume and occurred in 24.9% of the stomachs. Bramidae and Gempylidae occurred frequently and were moderately important in volume and Balistidae were common. Other surface organisms (Carangidae and Priacanthidae), which were common in our study, were surprisingly absent in the study by Dragovitch (1970a). Serranids occurred frequently, 53.8%, and constituted 56.9% of the total volume. Other high-ranking families in terms of occurrence and volume were Scombridae, Carangidae (mainly *Decapterus* sp.), Dactylopteridae (*Dactylopterus volitans*), and Chaetodontidae. Dragovich and Potthoff (1972) reported that the fish forage of yellowfins caught by live bait and trolling off the coast of West Africa consisted by occurrence and volume mainly of the epipelagic juveniles of Acanthuridae, Carangidae, Dactylopteridae, Lutjanidae, and Mullidae, and the midwater Gempylidae and Gonostomatidae.

In the diet of yellowfin tunas in the central Pacific, acanthurids and bramids, particularly *Collybus*

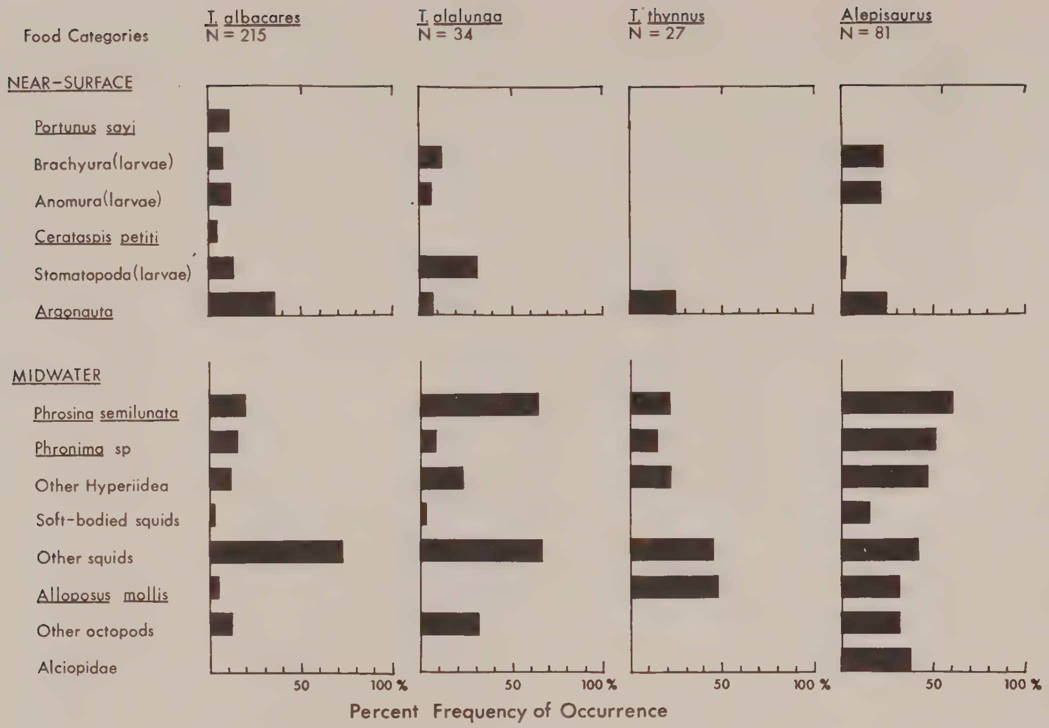


Figure 4.—Frequency of occurrence of invertebrate forage categories in the stomachs of *Thunnus* and *Alepisaurus*. Categories are separated by their general location in the water column: near-surface or midwater.

drachme, ranked high in number, volume, and frequency (Reintjes and King 1953). Exocoetids, scombrids (mainly *Katsuwonus pelamis*), and carangids (mainly *Decapterus* sp.) were important in volume, but were infrequently consumed. The most important fishes in the diet of central Pacific yellowfins were *Collybus drachme* and *Gempylus serpens* (King and Ikehara 1956). Scombridae and Mullidae were important in volume, though infrequently eaten. In the southwest Pacific, the families of fishes most frequently consumed by yellowfins were midwater Sternoptychidae (mostly *Argyropelecus* spp.), Paralepididae, and Bramidae, of which *Collybus drachme* was most important (Fourmanoir 1971). From the eastern tropical Pacific, Alverson (1963) reported Scombridae as the most important by volume (12.2%) followed in decreasing order of magnitude by Exocoetidae, Tetraodontidae, Carangidae, Myctophidae, and Serranidae.

Thunnus alalunga.—In stomachs of longline-caught albacore from the central and northeastern Pacific, the midwater families Gempylidae, Bramidae, Sternoptychidae, and Paralepididae were present most frequently (Iversen 1962). *Gempylus serpens* was the most frequently occurring species (9.9%) while *Collybus drachme* and *Sternoptyx* sp. were both present in 4.9% of the stomachs. In troll-caught albacore in California waters (Iversen 1971), however, the most important forage fishes in terms of both volume and frequency of occurrence were anchovies and sauries, with certain deeper-occurring fi
(*Tarletonbeania crenularis*, *Paralepis atlan*
Sebastes spp.) occurring less frequently. Albacore
New Caledonia (Fourmanoir 1971) consumed Stern
tychidae, particularly *Sternoptyx diaphana*,
Bramidae, especially *Collybus drachme* most freque

Thunnus thynnus.—Dragovich (1970b) repo
Bramidae (*Collybus drachme*) and the epipelagic Sc
bridae (particularly *Scomber scombrus* and *Auxis*
and Syngnathidae (*Hippocampus erectus*) as the m
frequently consumed fishes in western North Atlant
t. thynnus. In the stomachs of the northern Pa
bluefin, *T. thynnus orientalis*, however, Pinkas (19
found that *Engraulis mordax* was the primary fo
component (72.0% occurrence), followed by the
swimming crab, *Pleuroncodes planipes* (13.5% oc
rence), and the saury, *Cololabis saira* (11.9% occurren

Thunnus obesus.—In her studies on the food of bi
tuna from the Gulf of Guinea, Borodulina (1974) fo
midwater fishes, Paralepididae, Sternoptychi
Gonostomatidae, Omosudidae, Scopelarchidae,
Alepisauridae most frequently consumed. Gempyl
and Diretmidae were only occasionally utilized, but
curred in large numbers when they were present. In
eastern tropical Atlantic, Gempylidae, Trichiuri
Bramidae, Alepisauridae, and Myctophidae were

Table 5. (Continued)

TATION: E-11
28 M
DE: 28°55' N
UDE: 92°20' W

ruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	22	1	1963	15.5	15.5	15.4	15.5				15.5	35.22	35.09	35.13	35.33			
2	21	2	1963	13.9	14.2	14.7	15.7				15.7	33.36	34.12	34.88	35.73			
3	30	3	1963	20.1	20.0	19.9	19.7				19.7	34.91	34.92	35.37	35.58			
4	22	4	1963	22.4	22.4	21.9	20.7				20.6	35.01	35.06	36.10	36.44			
	15	5	1963	27.0	25.6	24.8	22.3				22.3	33.97	35.76	35.88	36.02			
	20	6	1963	28.9	28.9	28.9	24.9				24.9	32.11	31.98	32.22	35.10			
	11	7	1963	29.8	29.7	29.4	26.1				23.4	00.00	33.09	34.55	36.43			
8	18	8	1963	29.7	29.7	30.6	24.4				24.4	32.53	31.97	33.64	36.63			
9	23	9	1963	28.9	28.9	28.9	28.9				29.4	35.98	35.96	35.94	35.97			
10	21	10	1963	26.2	26.2	26.2	26.2				26.2	35.20	35.24	35.96	35.53			
	21	11	1963	22.3	22.3	22.3	22.3				22.2	35.69	35.60	35.61	35.67			
	11	12	1963	19.9	19.9	19.8	19.6				19.5	36.31	36.11	36.20	36.13			
	19	1	1964	16.7	16.7	16.7	16.6				15.1	36.71	36.73	36.85	36.65			
1	2	3	1964	15.0	15.0	15.0	15.0				15.0	34.85	35.33	35.40	35.36			
16	23	4	1964	21.7	21.7	21.7	21.0				20.5	36.85	36.84	36.89	36.80			
17	18	5	1964	24.4	24.4	24.4	24.3				24.3	36.37	36.40	36.41	36.47			
18	18	6	1964	28.2	28.1	27.6	26.0				25.9	35.97	36.23	36.70	36.69			
	13	7	1964	28.3	28.3	28.6	26.0				25.6	29.39	29.45	30.67	36.62			
	25	8	1964	29.7	29.7	29.7	27.4				27.4	32.75	32.71	32.77	36.30			
	19	9	1964	28.4	28.4	28.7	26.6				26.4	33.14	33.08	33.69	36.25			
22	22	10	1964	21.7	21.5	23.5	23.8				23.9	31.95	31.98	34.52	36.06			
23	14	11	1964	23.6	23.6	23.6	23.6				23.6	35.60	35.59	35.68	36.32			
24	12	12	1964	18.5	18.5	19.1	18.8				18.8	35.57	35.54	35.88	00.00			
	16	1	1965	19.4	19.4	19.4	19.5				19.7	35.42	35.40	35.67	35.62			
	14	3	1965	17.0	17.0	17.2	16.5				16.5	35.40	35.44	35.70	36.27			
	19	4	1965	22.3	22.2	22.0	20.7				20.8	35.80	35.87	36.18	36.38			
2	25	5	1965	25.3	25.3	25.0	24.9				24.9	36.80	36.79	36.71	36.73			
30	13	6	1965	28.5	28.3	27.7	27.0				27.0	36.55	36.45	36.54	36.94			
32	24	8	1965	29.3	29.3	29.2	27.1				26.8	31.74	31.98	32.30	36.77			
34	30	10	1965	22.9	23.0	23.5	25.0				24.9	32.82	32.70	33.18	35.65			
	2	12	1965	22.3	22.3	22.3	22.2				22.2	35.28	35.26	35.25	35.26			

N: E-10
EPTH: 46 M
ATITUDE: 28°32' N
ONGITUDE: 92°20' W

ruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	29	1	1963	18.7	18.7	18.6	18.4	17.8			17.8	36.51	36.53	36.56	36.57	36.52		
	21	2	1963	17.3	17.3	17.3	17.2	17.1			17.0	36.57	36.67	36.54	36.63	36.56		
	28	3	1963	20.2	20.1	20.1	19.7	19.4			19.3	36.61	35.64	36.67	36.40	36.46		
4	28	4	1963	24.6	24.5	24.4	22.6	21.7			20.5	36.65	36.57	36.58	36.56	36.45		
5	15	5	1963	25.2	25.0	24.7	24.3	20.4			20.0	36.41	36.30	36.30	36.65	36.32		
	20	6	1963	28.7	28.4	28.2	24.9	21.7			21.0	34.07	00.00	34.19	35.84	36.13		
	11	7	1963	29.6	29.6	29.4	23.8	21.1			21.0	33.83	34.23	34.62	35.51	36.49		
	18	8	1963	29.7	29.7	29.7	28.9	21.6			21.5	35.28	35.28	36.14	36.63	36.51		
	23	9	1963	29.0	28.9	28.9	28.7	25.3			25.3	36.20	36.30	36.19	36.25	36.47		
10	21	10	1963	26.7	26.7	26.7	26.7	26.7			26.7	36.64	36.33	36.40	36.52	36.60		
11	21	11	1963	24.3	24.3	24.2	24.2	24.1			24.0	36.77	36.86	36.83	36.79	36.82		
12	11	12	1963	21.9	21.9	21.7	21.7	21.1			21.1	36.70	36.70	36.82	36.76	36.86		
	19	1	1964	17.6	17.6	17.5	16.8	16.6			16.0	36.69	36.69	36.69	36.65	36.63		
	2	3	1964	16.7	16.7	16.7	16.6	16.3			16.3	36.81	36.64	36.66	36.74	36.60		
	23	4	1964	21.7	21.7	21.4	19.9	19.6			16.2	36.86	36.81	36.81	36.84	36.81		
17	14	5	1964	24.6	24.6	24.6	24.3	20.6			20.2	36.73	36.71	36.69	36.73	36.68		
18	21	6	1964	28.3	28.3	27.9	26.8	21.5			20.3	36.70	36.70	36.71	00.00	36.64		
19	11	7	1964	29.6	29.3	28.4	27.9	25.2			22.0	30.30	30.61	34.78	36.66	36.65		
	23	8	1964	29.7	29.7	29.7	28.7	23.2			22.6	32.84	32.82	32.83	36.36	36.61		
	19	9	1964	28.7	28.7	28.7	29.7	21.9			21.9	33.83	33.90	33.84	35.15	36.74		
	22	10	1964	23.3	23.3	23.8	23.3	23.5			22.8	35.70	35.67	35.89	35.92	36.30		
	12	11	1964	23.6	23.6	23.6	23.8	23.8			23.9	36.22	36.14	36.13	36.41	36.38		
24	10	12	1964	20.3	20.3	20.3	20.3	20.3			20.3	36.32	36.30	36.30	36.46	36.63		
25	16	1	1965	19.3	19.3	19.3	19.3	19.3			19.3	36.29	36.45	36.21	36.29	36.28		
27	14	3	1965	18.6	18.6	18.5	18.2	17.2			17.2	36.73	36.70	36.69	36.67	36.70		
	16	4	1965	22.3	22.3	22.2	22.2	19.5			19.3	36.48	36.38	36.40	36.42	36.47		
	25	5	1965	25.4	25.4	25.3	24.7	21.7			20.8	36.64	36.64	36.65	36.71	36.58		
	19	6	1965	28.3	28.3	28.2	26.8	22.7			21.7	36.38	38.06	36.54	36.54	36.71		
32	20	8	1965	29.3	29.2	29.2	27.5	22.0			22.0	32.97	32.97	34.88	36.68	36.71		
34	30	10	1965	24.1	24.1	24.1	24.1	24.9			24.9	35.32	35.34	35.28	35.23	35.72		
35	2	12	1965	22.9	22.9	22.9	22.8	22.7			22.7	35.71	35.71	35.68	35.61	35.70		

Table 5. (Continued)

STATION: E-50
DEPTH: 73 M
LATITUDE: 28°10' N
LONGITUDE: 92°20' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	29	1	1963	20.2	20.2	20.1	20.1	20.0	19.7		19.7	36.52	36.59	36.60	36.46	36.56	36.53
2	21	2	1963	18.3	18.2	18.2	18.1	18.1	17.4		17.4	37.09	36.88	36.61	36.75	36.68	36.56
3	28	3	1963	20.2	20.2	20.0	19.6	18.2	17.7		17.7	36.55	36.61	36.59	36.57	36.41	36.61
4	28	4	1963	23.8	23.8	23.6	22.1	20.0	18.4		18.4	36.57	00.00	00.00	36.66	36.54	36.44
5	15	5	1963	25.4	24.9	24.8	23.3	21.7	19.0		19.0	36.42	36.35	36.35	36.72	36.61	36.39
6	20	6	1963	28.9	28.9	28.8	26.1	22.2	19.4		19.4	34.58	34.55	34.59	35.71	36.45	35.03
7	11	7	1963	29.6	29.6	29.4	28.9	25.8	19.7		19.1	36.10	36.22	36.06	36.41	36.57	36.43
8	18	8	1963	29.9	29.9	30.2	29.2	24.7	20.2		19.2	35.41	35.47	35.68	00.00	36.40	36.48
9	23	9	1963	28.7	28.7	28.6	28.6	24.0	18.6		18.6	36.42	36.40	36.24	36.28	36.45	36.39
10	21	10	1963	26.9	26.8	26.8	26.7	26.7	25.6		22.8	36.71	36.72	36.66	36.85	36.65	36.67
11	21	11	1963	24.2	24.2	24.2	24.2	24.2	24.2		24.2	36.89	36.73	36.70	36.82	36.72	36.75
12	11	12	1963	22.7	22.7	22.6	22.4	22.4	22.2		22.2	36.79	36.68	36.69	36.72	36.70	37.01
13	19	1	1964	18.7	18.7	18.6	18.5	18.2	17.7		17.6	36.73	36.70	36.68	36.65	36.68	36.63
15	2	3	1964	18.2	18.2	18.2	18.1	17.8	17.6		17.6	36.66	00.00	00.00	00.00	00.00	00.00
16	23	4	1964	22.9	22.9	22.5	20.2	18.9	17.6		16.5	36.88	36.90	36.84	36.80	36.85	36.77
17	14	5	1964	25.2	25.2	25.1	24.6	20.0	18.6		18.4	36.72	36.73	36.70	36.76	36.59	36.62
18	21	6	1964	28.3	28.3	28.2	26.3	21.2	18.2		18.1	36.49	36.48	36.63	36.81	36.60	36.65
19	10	7	1964	29.6	29.3	28.8	28.4	23.4	19.0		17.4	32.40	32.67	35.16	36.07	36.68	36.60
20	23	8	1964	29.7	29.7	29.7	29.5	24.4	19.4		19.4	36.46	36.41	36.40	36.39	36.70	36.61
21	18	9	1964	28.5	28.7	28.9	29.2	23.8	19.0		18.6	33.40	33.49	34.18	36.35	36.53	36.45
22	22	10	1964	23.9	23.9	23.9	23.9	24.1	21.7		21.0	36.29	36.22	36.29	36.20	36.31	36.48
23	12	11	1964	23.9	23.9	23.9	23.9	24.0	22.5		20.7	35.91	36.00	36.02	35.95	35.91	36.41
24	9	12	1964	22.1	22.1	22.1	22.1	22.1	22.1		22.1	36.68	36.73	36.75	36.70	36.69	36.74
25	16	1	1965	21.1	21.1	21.1	21.0	20.6	20.4		20.3	36.97	36.76	36.80	36.98	36.77	36.58
27	14	3	1965	19.3	19.3	19.3	18.7	17.6	17.4		17.4	36.75	36.67	36.67	36.77	36.65	36.75
28	16	4	1965	23.2	23.2	23.1	20.8	19.3	18.2		18.0	36.57	36.65	36.61	36.69	36.61	36.58
29	26	5	1965	25.6	25.6	25.4	24.7	21.3	19.0		19.0	36.43	36.38	36.38	36.51	36.69	36.60
30	20	6	1965	25.9	25.9	25.8	23.3	20.6	19.6		19.6	35.66	35.79	35.77	36.48	36.59	36.34
32	20	8	1965	27.8	27.8	26.9	22.8	20.0	18.9		18.9	33.20	33.24	33.72	36.53	36.71	36.71
34	30	10	1965	25.0	25.0	25.1	25.2	24.5	22.2		22.1	35.74	36.47	36.04	36.12	36.38	36.42
35	2	12	1965	23.6	23.6	23.7	23.7	23.7	22.0		21.6	36.13	36.11	36.24	36.11	36.29	36.38

Table 6. Monthly temperature and salinity observations at stations on transect 6, 1963-1965

STATION: E-52
DEPTH: 7 M
LATITUDE: 29°42' N
LONGITUDE: 93°18' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	2	3	1963	12.2	12.2						12.3	29.30	30.02				
3	31	3	1963	20.7	20.7						20.7	26.92	26.83				
4	21	4	1963	23.6	22.6						22.6	28.12	26.90				
5	14	5	1963	26.2	26.1						24.7	27.93	34.90				
6	23	6	1963	28.9	28.9						24.7	32.30	32.30				
7	10	7	1963	29.9	29.9						29.4	32.74	32.84				
8	23	8	1963	30.3	30.2						30.2	32.63	32.67				
9	28	9	1963	26.2	26.3						26.4	30.47	30.34				
10	20	10	1963	25.4	25.4						25.3	30.91	30.84				
11	20	11	1963	19.2	19.2						19.1	31.78	31.62				
12	16	12	1963	11.1	11.1						11.0	32.31	32.52				
13	24	1	1964	10.9	9.4						9.5	32.23	32.34				
14	8	2	1964	10.9	10.9						11.3	30.64	30.61				
16	25	4	1964	24.5	24.4						24.0	16.89	18.09				
17	19	5	1964	26.0	26.0						25.5	19.76	19.76				
18	18	6	1964	29.7	29.7						28.4	20.71	20.65				
19	14	7	1964	28.5	28.5						28.4	30.84	30.88				
20	26	8	1964	29.6	29.6						29.5	34.69	34.62				
21	22	9	1964	27.9	27.9						28.0	30.66	30.55				
22	25	10	1964	20.6	20.6						20.6	00.00	00.00				
23	14	11	1964	22.6	22.6						22.5	29.86	29.88				
24	13	12	1964	13.0	13.0						13.3	29.66	28.77				
25	15	1	1965	15.3	15.6						15.7	28.47	29.30				
26	13	2	1965	13.6	13.6						15.3	27.61	27.47				
27	17	3	1965	16.4	16.3						16.2	27.61	27.47				
28	19	4	1965	25.2	24.1						23.3	26.10	26.08				
29	19	5	1965	26.0	26.1						25.8	10.18	13.35				
32	24	8	1965	28.8	29.0						29.1	29.63	29.67				
35	5	12	1965	17.3	17.1						17.0	00.00	00.00				

Table 6. (Continued)

TION: E-1
14 M
: 29°22' N
E: 93°20' W

Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
			Depth (M)								Depth (M)						
			0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
22	1	1963	12.1	12.0	11.9					11.9	33.84	33.80	34.03				
20	2	1963	12.1	12.2	12.2					12.3	33.63	33.92	33.90				
31	3	1963	19.1	19.1	19.2					19.2	34.20	34.51	34.53				
21	4	1963	22.8	22.9	22.5					22.1	31.50	31.57	32.25				
14	5	1963	25.8	25.8	25.3					25.2	30.06	30.12	33.53				
23	6	1963	29.1	29.1	29.1					25.2	33.25	33.22	33.20				
10	7	1963	29.9	29.9	29.9					29.9	33.58	33.73	33.91				
23	8	1963	31.7	31.1	30.6					30.6	34.90	00.00	00.00				
27	9	1963	27.1	27.1	27.1					27.1	32.94	32.87	32.95				
20	10	1963	25.6	25.6	25.6					26.5	33.11	33.16	33.18				
20	11	1963	20.7	20.7	20.7					20.7	34.57	34.57	34.55				
16	12	1963	14.2	14.2	14.2					14.1	35.30	35.23	35.21				
24	1	1964	11.3	10.9	10.4					10.3	34.31	34.64	34.85				
8	2	1964	11.8	11.8	11.7					11.7	34.85	35.11	35.03				
25	4	1964	23.4	23.4	23.0					22.9	28.14	28.21	29.05				
18	5	1964	25.6	25.6	25.2					24.9	27.36	27.35	30.65				
18	6	1964	28.6	28.6	28.5					26.9	27.13	27.24	27.20				
14	7	1964	28.9	28.8	28.1					28.1	28.80	28.78	30.98				
26	8	1964	29.4	29.4	29.7					29.6	32.77	33.08	33.38				
21	9	1964	28.6	28.6	28.4					28.2	32.38	32.36	32.23				
25	10	1964	21.5	21.5	21.5					21.5	33.75	33.79	33.78				
15	11	1964	22.7	22.7	22.7					22.7	23.98	32.88	32.88				
13	12	1964	16.0	16.0	16.2					16.3	33.62	33.55	34.30				
15	1	1965	18.1	18.1	18.1					18.1	34.85	34.92	34.98				
13	2	1965	14.5	14.5	14.5					14.5	31.24	31.23	31.42				
17	3	1965	16.2	16.1	14.4					14.5	30.42	30.46	31.01				
19	4	1965	24.4	23.0	22.2					22.0	29.10	30.39	31.66				
19	5	1965	25.5	25.5	25.1					25.0	25.94	30.03	33.70				
24	6	1965	29.1	29.1	28.8					28.6	31.42	31.14	32.18				
24	8	1965	28.3	28.4	29.3					29.5	29.91	30.17	31.94				
5	12	1965	19.7	19.6	19.6					19.6	33.77	33.82	34.14				

E-2
TH: 28 M
ITUDE: 28°46' N
GITUDE: 93°20' W

Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
			Depth (M)								Depth (M)						
			0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
30	1	1963	17.6	16.6	17.4	17.2				17.2	36.58	36.52	36.58	36.50			
20	2	1963	16.7	16.7	16.7	16.7				16.7	36.56	36.56	36.71	36.56			
27	3	1963	19.7	19.6	19.6	19.4				19.4	36.51	36.49	36.51	36.75			
29	4	1963	23.6	23.6	23.6	21.8				21.8	36.54	36.50	36.41	36.37			
14	5	1963	25.1	24.8	24.7	24.1				23.8	35.62	35.72	35.72	36.59			
19	6	1963	28.9	28.9	28.4	23.7				23.7	32.50	32.46	32.54	35.12			
10	7	1963	30.1	29.8	28.6	25.6				23.7	34.17	34.17	34.67	36.17			
17	8	1963	29.9	29.9	29.9	27.3				27.3	36.10	35.99	36.02	32.27			
22	9	1963	29.1	29.1	29.1	29.1				29.1	36.12	36.10	36.03	36.45			
20	10	1963	26.6	26.5	26.4	26.4				26.2	35.57	35.40	35.34	35.44			
20	11	1963	22.6	22.5	22.2	22.3				22.3	35.98	36.12	35.91	36.13			
10	12	1963	19.3	19.3	19.2	19.2				19.1	36.09	35.90	35.87	35.93			
19	1	1964	13.3	13.3	13.2	12.8				12.9	36.15	36.21	36.06	36.22			
24	2	1964	15.0	15.0	15.0	15.0				15.1	36.70	36.65	36.67	36.63			
3	3	1964	15.1	15.1	15.1	14.5				14.5	36.62	36.49	36.49	36.62			
22	4	1964	21.4	21.4	21.0	19.7				19.7	36.79	36.39	36.75	36.76			
13	5	1964	24.4	24.4	24.1	23.4				23.4	36.68	36.60	37.17	36.64			
22	6	1964	29.5	29.3	28.2	26.8				25.9	31.00	31.08	33.11	36.19			
10	7	1964	29.0	29.0	27.8	25.5				24.3	30.25	30.20	30.78	36.63			
21	8	1964	29.6	29.6	29.6	28.5				27.2	33.80	33.78	35.98	35.32			
18	9	1964	28.9	28.9	28.8	28.8				28.3	34.51	34.43	34.43	36.20			
21	10	1964	23.6	23.6	23.6	23.7				23.7	34.92	34.89	34.90	34.98			
11	11	1964	22.7	22.7	22.8	23.1				23.2	34.21	34.19	34.38	34.74			
9	12	1964	19.1	19.1	19.1	18.9				18.9	35.48	35.49	35.50	35.57			
15	1	1965	18.7	18.6	18.5	18.4				18.4	36.19	36.14	36.08	36.10			
13	3	1965	17.0	17.0	16.6	16.3				16.2	36.52	36.57	36.68	36.71			
15	4	1965	22.1	22.1	22.0	19.5				18.8	35.97	35.90	35.80	35.78			
26	5	1965	25.5	25.5	25.3	25.0				25.0	36.51	36.50	36.46	36.46			
19	6	1965	28.4	28.4	27.7	26.8				26.8	36.67	36.71	36.71	36.69			
19	8	1965	29.2	29.3	29.0	28.3				27.8	33.38	32.80	33.51	36.49			
31	10	1965	23.7	23.7	23.7	24.0				24.2	34.52	00.00	33.47	34.72			
1	12	1965	22.8	22.7	22.7	22.7				22.7	35.50	35.44	35.44	35.41			

Table 6. (Continued)

STATION: E-3
DEPTH: 46 M
LATITUDE: 28°28' N
LONGITUDE: 93°20' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	30	1	1963	18.7	18.7	18.6	17.8	17.7			17.7	36.49	36.46	36.57	36.55	36.57	
2	20	2	1963	18.0	17.9	17.9	17.8	17.8			16.8	36.60	37.01	36.67	36.68	36.69	
3	27	3	1963	20.5	20.4	20.3	20.0	18.3			18.3	36.59	36.64	36.65	36.62	36.61	
4	29	4	1963	24.2	24.2	24.2	22.2	20.4			20.3	00.00	36.43	36.39	36.47	36.52	
5	14	5	1963	25.6	25.2	24.9	24.0	21.5			21.1	35.43	35.89	36.09	36.64	36.61	
6	19	6	1963	28.7	28.7	27.2	25.3	22.2			20.2	33.78	33.81	34.14	35.67	36.48	
7	11	7	1963	30.0	30.0	29.7	28.9	22.5			20.3	33.97	34.62	34.25	35.30	36.39	
8	17	8	1963	29.8	29.8	29.8	29.7	21.2			20.7	36.51	36.52	36.44	36.50	36.43	
9	22	9	1963	28.6	28.6	28.6	28.5	27.2			26.3	36.32	36.34	36.28	36.14	36.50	
10	20	10	1963	26.8	26.8	26.8	26.7	26.7			26.7	36.68	36.60	36.67	36.59	36.65	
11	20	11	1963	24.2	24.2	24.1	23.9	23.9			23.9	36.82	36.79	36.90	36.82	36.88	
12	10	12	1963	21.3	21.3	21.3	21.3	20.7			20.4	36.80	36.72	00.00	36.72	36.86	
13	19	1	1964	16.7	16.7	16.7	16.3	16.1			16.0	36.65	36.56	36.60	36.52	36.54	
14	24	2	1964	16.8	16.8	16.8	16.8	16.6			16.4	36.64	36.65	36.67	36.63	36.56	
15	2	3	1964	17.6	17.6	17.5	17.3	16.6			16.6	36.61	36.69	36.64	36.60	36.69	
16	22	4	1964	22.1	22.1	21.4	19.6	19.0			19.0	36.76	36.72	36.94	36.98	36.91	
17	13	5	1964	24.9	24.9	24.4	23.4	20.7			20.1	36.48	36.42	36.66	36.70	36.72	
18	21	6	1964	29.4	28.9	28.2	27.7	20.6			20.6	36.36	36.26	36.22	36.42	36.48	
19	10	7	1964	28.6	28.6	28.1	27.6	23.2			21.2	34.30	34.23	34.80	36.31	36.58	
20	21	8	1964	29.7	29.7	29.7	28.7	22.7			21.8	34.58	34.39	34.47	36.10	36.60	
21	18	9	1964	28.8	28.8	28.8	28.5	23.7			21.2	36.07	36.06	36.08	36.42	36.63	
22	21	10	1964	24.0	23.9	23.8	23.7	24.0			23.9	35.48	36.59	35.38	35.30	35.32	
23	11	11	1964	24.3	24.3	24.3	24.6	24.6			24.6	36.21	36.30	36.16	36.18	36.48	
24	9	12	1964	21.4	21.4	21.4	21.4	21.4			21.4	36.41	36.49	36.54	36.39	36.48	
25	15	1	1965	20.7	20.7	20.6	19.9	19.8			19.6	36.61	36.62	36.66	36.49	36.46	
27	13	3	1965	18.7	18.7	18.6	18.3	18.1			17.7	36.85	36.72	36.70	36.69	36.73	
28	15	4	1965	22.5	22.5	22.2	19.2	18.3			18.3	36.57	36.54	36.54	36.57	36.56	
29	26	5	1965	25.3	25.3	25.2	25.1	22.6			22.6	36.70	36.67	36.64	36.61	36.56	
30	19	6	1965	28.6	28.6	28.0	26.0	23.8			22.1	36.71	36.60	36.74	36.65	00.00	
32	19	8	1965	29.1	29.1	29.2	28.8	23.3			23.0	35.14	34.94	34.99	36.09	36.59	
34	31	10	1965	24.8	24.8	24.8	24.8	25.0			25.3	35.62	35.64	35.57	35.63	35.74	
35	1	12	1965	22.4	22.4	22.3	22.3	22.2			22.2	35.77	36.09	35.97	35.93	35.93	
STATION: E-51 DEPTH: 73 M LATITUDE: 28°09' N LONGITUDE: 93°20' W																	
1	30	1	1963	19.7	19.6	19.6	19.5	19.4	18.5		18.5	36.55	36.49	36.55	36.55	36.57	36.55
2	20	2	1963	18.6	18.5	18.4	18.4	18.3	18.2		17.7	36.69	37.05	36.79	36.59	36.80	36.68
3	27	3	1963	20.1	20.1	19.7	19.2	18.7	17.9		17.9	36.68	36.67	36.62	36.59	36.63	36.50
4	29	4	1963	23.8	23.8	23.8	22.2	20.1	18.6		18.5	36.40	36.52	36.48	00.00	36.47	36.49
5	15	5	1963	25.7	25.4	25.3	24.9	22.7	19.3		19.3	35.68	35.68	36.22	36.43	36.61	36.61
6	19	6	1963	28.5	28.5	28.4	25.6	22.8	19.7		19.3	35.04	35.23	35.31	35.76	36.47	36.55
7	11	7	1963	29.3	29.3	28.9	27.3	21.7	18.7		17.9	34.19	34.17	34.59	36.23	36.54	34.84
8	17	8	1963	29.6	29.6	29.6	29.6	24.3	19.4		18.9	36.60	36.52	36.63	36.44	36.43	36.65
9	22	9	1963	27.7	28.2	28.1	28.1	25.8	20.0		20.0	36.75	36.67	37.03	36.73	36.58	36.49
10	21	10	1963	26.8	26.8	26.7	26.7	26.7	22.8		22.1	36.71	36.82	36.66	36.78	36.68	36.48
11	21	11	1963	24.7	24.6	24.6	24.5	24.4	24.4		20.7	36.69	36.79	36.69	36.79	36.76	36.84
12	11	12	1963	22.8	22.8	22.8	22.8	22.7	22.3		22.1	36.89	36.79	36.73	36.68	36.76	36.72
13	18	1	1964	17.9	17.9	17.9	17.8	17.7	17.7		17.7	36.68	36.77	36.80	36.69	36.80	36.71
14	24	2	1964	17.6	17.6	17.6	17.6	17.3	17.1		17.1	36.66	36.68	36.65	36.59	36.67	36.65
15	2	3	1964	17.5	17.5	17.4	17.4	17.3	17.1		17.1	36.69	36.59	36.70	36.69	36.65	36.64
16	22	4	1964	22.0	21.9	19.5	18.7	17.7	16.8		16.9	36.70	36.72	36.76	36.84	36.83	36.78
17	13	5	1964	25.5	25.4	25.3	23.5	19.8	17.8		17.8	36.43	36.34	36.34	36.34	00.00	00.00
18	21	6	1964	28.9	28.9	28.9	27.5	23.3	20.2		20.2	35.73	35.69	35.99	36.59	36.64	36.18
19	10	7	1964	29.0	28.9	28.7	27.5	21.4	18.2		17.9	33.85	33.80	34.44	36.31	36.65	36.64
20	21	8	1964	29.9	29.9	29.8	27.4	21.1	18.7		18.7	35.04	34.95	34.98	35.29	35.43	36.43
21	18	9	1964	28.8	28.8	28.8	28.8	23.2	19.2		19.2	36.23	36.17	36.15	36.17	36.50	36.71
22	21	10	1964	23.8	23.8	23.8	24.1	23.8	21.9		20.6	35.88	35.85	35.87	36.32	36.40	36.46
23	11	11	1964	24.9	24.9	24.9	24.8	24.7	22.7		19.6	36.38	36.41	36.37	36.68	36.45	36.65
24	9	12	1964	21.9	21.9	21.9	21.8	21.8	21.8		19.8	36.75	36.76	36.73	36.82	36.77	36.74
25	16	1	1965	21.3	21.3	21.2	21.2	21.1	21.0		20.9	36.79	36.74	36.91	36.76	36.78	36.75
27	13	3	1965	19.3	19.3	19.2	18.6	18.4	18.1		17.2	36.52	36.48	36.58	36.56	36.60	36.71
28	15	4	1965	22.9	22.9	22.8	21.1	18.9	18.2		17.9	36.60	36.57	36.58	36.55	36.56	36.65
29	26	5	1965	25.3	25.3	25.3	25.1	20.3	19.0		19.0	36.55	36.54	36.58	36.55	36.60	36.64
30	19	6	1965	28.8	26.1	25.3	22.6	19.6	19.2		19.2	36.31	36.25	35.84	36.47	36.65	36.63
32	19	8	1965	29.1	28.6	28.6	24.4	20.1	19.3		19.3	34.88	34.64	37.79	35.68	36.71	33.77
34	31	10	1965	24.5	24.5	24.5	24.6	25.3	23.2		23.2	35.69	35.35	35.36	35.46	36.13	36.40
35	1	12	1965	23.6	23.6	23.6	23.6	23.6	23.6		22.2	36.09	36.06	36.06	36.08	36.06	36.06

Table 6. (Continued)

E-6
110 M
: 27°59' N
E: 93°20' W

	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
1	30	1	1963	20.3	20.3	20.2	20.2	20.0	19.9	19.1	19.1	36.58	36.50	36.51	36.55	36.51	36.50	36.59
2	21	2	1963	19.2	19.1	19.1	18.9	18.8	18.7	15.9	15.7	36.81	36.61	36.61	36.73	36.65	36.58	36.21
3	27	3	1963	20.0	19.9	19.8	19.6	19.1	17.8	17.7	17.7	36.62	36.62	36.60	36.64	36.51	36.43	36.54
5	15	5	1963	25.6	25.2	25.2	25.1	20.4	19.8	18.6	18.4	36.35	36.25	36.29	36.32	36.40	36.58	36.49
	19	6	1963	29.1	29.1	28.9	27.4	25.0	20.3	18.3	17.7	35.30	35.17	35.36	36.65	36.52	36.54	36.43
	11	7	1963	29.1	29.3	28.6	26.1	22.2	18.6	17.7	17.7	33.91	33.86	35.25	36.31	36.52	36.51	36.53
8	17	8	1963	29.8	29.8	29.8	29.7	23.3	20.0	17.8	16.4	00.00	36.46	36.87	36.62	36.45	36.38	36.33
9	22	9	1963	28.5	28.4	28.3	28.2	26.8	20.8	17.2	17.2	36.61	00.00	36.56	36.54	36.57	36.97	36.44
10	21	10	1963	26.7	26.7	26.7	26.7	26.6	23.9	20.3	20.3	36.91	36.60	36.59	36.66	36.62	36.48	36.65
11	21	11	1963	24.8	24.8	24.7	24.7	24.6	24.4	19.2	19.1	36.60	00.00	00.00	00.00	00.00	00.00	00.00
	11	12	1963	22.9	22.9	22.9	22.9	22.9	22.8	17.9	17.7	36.65	36.61	37.11	36.95	36.76	36.68	36.31
	18	1	1964	18.7	18.7	18.6	18.3	17.9	17.8	17.6	17.6	36.68	36.68	36.68	36.72	36.68	36.77	36.74
	24	2	1964	16.6	16.6	16.6	16.3	16.2	16.0	15.9	15.8	36.57	36.60	36.62	36.56	36.58	36.70	36.57
15	2	3	1964	18.3	18.3	18.4	18.3	18.3	18.0	17.2	17.4	36.60	36.66	36.58	36.66	36.75	36.69	36.66
16	22	4	1964	23.1	23.0	22.8	21.3	20.3	18.7	17.1	16.8	36.88	36.84	36.83	36.92	36.74	36.85	36.67
17	13	5	1964	25.3	25.4	25.3	24.7	22.3	18.8	17.3	17.3	36.20	36.19	36.26	36.68	36.68	36.61	36.48
	21	6	1964	28.6	28.4	28.2	26.7	21.7	19.3	17.2	17.2	00.00	35.54	35.63	36.57	36.64	36.59	3..55
	10	7	1964	28.8	28.8	28.6	25.6	20.9	18.7	17.2	17.2	33.71	33.68	33.60	35.90	36.73	36.54	36.47
	21	8	1964	30.1	30.1	29.9	28.9	22.5	18.1	17.3	17.3	35.22	35.23	35.59	36.60	36.57	36.37	36.39
21	18	9	1964	29.2	29.2	29.2	29.2	29.0	20.4	18.5	17.4	36.69	36.72	36.78	36.72	36.70	36.61	36.55
22	22	10	1964	23.9	24.0	23.9	23.9	23.8	22.8	18.4	18.3	36.40	36.41	36.43	36.42	36.45	36.48	36.41
23	11	11	1964	25.3	25.3	25.2	25.2	25.1	23.9	19.0	18.6	36.78	36.52	36.48	36.50	36.57	36.53	36.45
24	9	12	1964	22.4	22.4	22.4	22.4	22.4	22.6	19.4	19.4	36.79	36.75	36.74	36.69	36.74	36.78	36.70
	16	1	1965	21.9	21.9	21.9	21.9	21.8	21.8	17.8	17.8	36.85	37.01	36.99	36.89	36.82	36.81	36.50
	15	4	1965	23.9	23.6	23.3	22.8	20.4	19.7	17.9	17.8	36.54	36.57	36.62	36.63	36.57	36.55	36.42
	26	5	1965	25.6	25.6	25.6	25.1	21.4	19.3	17.9	17.9	36.65	36.45	36.46	36.74	36.59	36.60	36.48
30	19	6	1965	25.9	25.9	25.1	22.8	20.5	19.3	18.1	18.1	36.10	35.96	35.66	36.51	36.54	36.73	36.64
32	19	8	1965	29.4	29.4	28.3	25.3	22.0	19.6	16.7	16.5	35.54	35.47	35.75	36.23	36.67	36.80	36.45
34	31	10	1965	25.4	25.3	25.3	25.2	25.2	25.0	20.2	20.0	36.66	36.33	36.33	36.34	36.40	36.43	36.60

Table 7. Monthly temperature and salinity observations at stations on transect 7, 1963-1965

W-55
PTH: 7 M
TITUDE: 29°03' N
NGITUDE: 95°06' W

	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
2	11	3	1963	14.7	14.8						14.8	31.47	31.43					
	2	4	1963	22.2	22.2						20.4	28.97	28.97					
	7	5	1963	25.2	25.3						24.0	22.68	23.23					
	19	5	1963	26.7	26.6						23.2	33.68	34.82					
6	1	7	1963	29.0	28.9						28.8	34.90	34.81					
7	17	7	1963	28.7	28.7						28.4	36.15	36.17					
8	28	8	1963	31.1	31.1						31.1	37.06	36.97					
	1	10	1963	25.9	25.9						25.9	29.29	29.26					
	31	10	1963	24.6	24.6						24.6	30.74	30.67					
	30	11	1963	16.2	00.0						00.0	31.99	32.10					
12	19	12	1963	11.8	11.8						11.6	32.18	32.09					
13	26	1	1964	9.9	9.7						9.4	32.01	31.83					
14	19	2	1964	12.4	12.4						12.2	33.55	33.72					
15	22	3	1964	15.1	15.0						14.6	31.78	31.93					
	15	4	1964	19.7	19.6						19.4	25.81	25.76					
	22	5	1964	27.1	27.1						26.2	23.47	23.49					
18	24	6	1964	29.6	29.6						25.8	31.58	31.59					
19	16	7	1964	28.5	28.5						28.5	34.52	34.79					
20	29	8	1964	29.6	29.6						29.6	36.64	36.62					
21	25	9	1964	28.0	28.0						28.0	30.45	30.41					
	28	10	1964	21.9	21.9						21.9	31.96	32.02					
	19	11	1964	23.5	23.5						23.5	31.10	31.05					
	19	12	1964	12.1	12.1						12.1	28.66	28.61					
25	10	1	1965	15.4	15.4						16.0	30.45	30.41					
26	26	2	1965	13.8	14.2						14.2	32.78	33.13					
27	20	3	1965	14.7	14.7						14.5	30.16	30.12					
28	23	4	1965	23.9	23.9						23.8	28.96	29.01					
	2	6	1965	27.3	27.3						26.4	21.06	20.96					
	15	6	1965	29.3	28.8						25.9	24.70	25.68					
32	11	8	1965	29.0	28.9						28.7	34.84	35.07					
33	8	9	1965	29.8	29.7						29.6	00.00	00.00					
35	9	12	1965	17.3	17.2						17.1	00.00	00.00					

Table 7. (Continued)

STATION: W-1
DEPTH: 14 M
LATITUDE: 29°01' N
LONGITUDE: 95°05' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	6	2	1963	10.3	10.3	10.9					10.8	31.00	31.00	31.70			
2	2	3	1963	12.8	12.8	12.8					12.8	31.31	31.40	31.31			
3	3	4	1963	21.9	22.0	19.4					19.2	29.34	29.40	32.40			
4	7	5	1963	25.2	25.3	24.0					23.9	00.00	32.62	34.11			
5	20	5	1963	25.6	26.1	23.2					23.0	34.32	34.92	35.81			
6	1	7	1963	28.9	28.9	28.6					28.1	34.69	34.69	35.26			
7	17	7	1963	29.3	29.3	29.3					29.3	36.53	36.38	36.61			
8	28	8	1963	30.4	30.2	30.1					30.1	00.00	36.94	36.92			
9	2	10	1963	26.0	26.1	26.2					26.1	30.22	30.36	30.68			
10	31	10	1963	24.3	24.4	24.9					25.1	30.81	30.76	32.56			
11	30	11	1963	17.4	17.4	17.5					17.6	33.20	33.13	33.35			
12	19	12	1963	12.3	12.3	12.3					12.3	32.59	32.52	32.54			
13	26	1	1964	9.8	9.8	9.8					9.9	32.79	32.87	34.01			
14	19	2	1964	12.4	12.4	12.4					12.4	35.02	34.91	34.97			
15	22	3	1964	15.1	15.1	14.9					14.9	31.93	32.08	34.80			
16	15	4	1964	19.4	19.4	19.3					19.2	28.78	28.88	29.31			
17	22	5	1964	26.4	26.4	26.3					25.8	26.34	26.40	27.05			
18	25	6	1964	29.0	28.6	25.8					25.0	31.61	31.83	34.29			
19	16	7	1964	27.9	27.9	26.8					26.5	34.84	34.82	34.87			
20	29	8	1964	29.3	29.3	29.3					29.2	36.37	36.37	36.33			
21	25	9	1964	27.9	27.9	27.9					27.9	31.40	31.33	31.49			
22	28	10	1964	22.0	22.0	22.0					22.1	32.86	32.88	32.89			
23	19	11	1964	23.9	23.0	23.0					23.0	31.00	30.98	30.99			
24	19	12	1964	12.8	12.8	13.2					13.3	30.15	30.12	30.61			
25	10	1	1965	15.4	15.4	15.5					16.3	30.51	30.52	33.79			
26	26	2	1965	13.7	14.0	14.7					14.7	33.37	33.68	35.55			
27	21	3	1965	14.8	14.8	14.9					14.9	32.47	32.39	32.40			
28	23	4	1965	23.4	23.3	23.2					23.0	29.97	29.96	30.02			
29	2	6	1965	27.1	27.1	26.7					26.6	21.16	21.12	31.94			
30	15	6	1965	29.3	28.7	25.6					25.5	24.51	26.59	34.81			
32	11	8	1965	29.0	29.0	28.6					28.5	34.87	35.28	35.32			
33	9	9	1965	29.6	29.5	29.4					29.4	00.00	00.00	00.00			
35	9	12	1965	18.9	18.9	18.9					18.9	00.00	00.00	00.00			

STATION: W-2
DEPTH: 28 M
LATITUDE: 28°40' N
LONGITUDE: 94°56' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	31	1	1963	13.4	13.2	12.7	13.4				13.4	35.45	35.50	35.30	35.78		
2	3	3	1963	14.2	13.7	13.5	13.8				13.8	35.73	35.73	35.68	35.98		
3	3	4	1963	20.1	19.7	19.3	18.5				18.5	36.17	36.23	36.46	36.24		
4	7	5	1963	23.7	24.1	24.2	23.6				23.3	34.13	34.97	35.24	35.37		
5	20	5	1963	26.4	26.4	25.7	23.1				22.8	32.29	32.24	33.53	36.08		
6	26	6	1963	28.7	28.6	28.6	26.1				26.0	34.45	34.93	34.91	35.58		
7	17	7	1963	29.2	29.2	29.2	28.8				24.7	36.44	36.44	36.38	36.37		
8	31	8	1963	29.9	29.8	29.7	29.6				28.6	36.62	36.89	36.57	36.64		
9	2	10	1963	27.5	27.5	27.5	27.5				27.4	36.33	36.37	36.36	36.32		
10	31	10	1963	25.7	25.7	25.7	25.6				25.6	36.24	36.28	36.30	36.27		
11	30	11	1963	20.8	20.8	20.8	20.8				20.7	36.24	36.17	36.21	36.19		
12	19	12	1963	17.3	17.3	17.3	17.3				17.2	36.21	36.39	36.31	36.61		
13	26	1	1964	14.8	14.8	14.8	14.4				13.8	36.53	36.64	36.66	36.77		
14	23	2	1964	13.7	13.6	13.6	13.7				13.8	36.31	36.19	36.21	36.24		
15	18	3	1964	17.3	17.3	17.1	16.8				16.8	36.81	36.68	36.70	36.70		
16	15	4	1964	18.6	18.6	18.6	18.6				18.4	36.56	36.53	36.68	36.57		
17	22	5	1964	25.2	25.2	25.2	24.3				24.1	36.15	36.14	36.20	36.29		
18	25	6	1964	28.3	28.2	28.1	26.4				24.8	32.74	32.65	32.85	35.05		
19	16	7	1964	28.5	28.5	28.6	23.1				23.1	34.02	34.00	34.84	36.34		
20	29	8	1964	29.4	29.4	29.4	29.1				29.1	35.12	35.10	35.55	36.12		
21	29	9	1964	27.9	27.9	28.0	28.3				28.3	34.97	00.00	35.01	35.42		
22	28	10	1964	23.5	23.5	23.4	23.4				23.3	35.06	35.07	35.04	35.09		
23	27	11	1964	21.7	21.7	21.6	21.5				21.5	35.41	35.56	35.45	35.40		
24	16	12	1964	18.3	18.3	18.3	18.2				18.3	35.36	35.33	35.40	00.00		
25	7	1	1965	16.3	16.3	16.4	16.6				16.6	34.50	34.50	34.99	35.33		
26	26	2	1965	16.5	16.5	16.5	16.5				16.5	36.62	36.62	36.58	36.59		
27	21	3	1965	15.9	15.9	15.8	15.8				15.7	36.00	35.95	35.91	35.98		
28	23	4	1965	22.4	22.3	22.2	21.6				21.6	36.59	36.57	36.59	36.46		
29	2	6	1965	27.1	27.1	25.5	25.0				25.0	22.68	22.58	35.09	35.68		
30	11	6	1965	29.7	28.9	26.5	26.0				25.8	30.89	31.50	34.66	36.36		
32	11	8	1965	29.2	29.1	29.2	28.3				28.3	34.02	34.84	35.04	35.02		
33	9	9	1965	29.3	29.3	29.2	29.1				29.2	00.00	00.00	00.00	00.00		
35	9	12	1965	21.2	21.2	21.2	21.2				21.1	00.00	00.00	00.00	00.00		

Table 7. (Continued)

STATION: W-3
46 M
DE: 28°18' N
UDE: 94°46' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	31	1	1963	18.7	18.6	18.2	17.7	17.1			15.9	36.32	36.37	36.54	36.60	36.56		
2	3	3	1963	18.2	18.1	18.1	17.9	17.2			17.4	36.55	36.55	36.60	36.56	36.57		
3	3	4	1963	21.9	21.9	21.7	19.5	19.0			18.9	36.71	36.61	36.54	36.59	36.61		
	7	5	1963	24.3	24.2	24.1	22.2	19.7			19.6	35.40	35.32	35.54	36.30	36.56		
	20	5	1963	26.6	26.6	25.7	23.2	20.6			20.2	32.24	32.39	34.91	36.50	36.63		
	26	6	1963	28.7	28.4	28.3	25.0	21.2			21.1	35.88	35.86	35.98	36.39	36.39		
	17	7	1963	29.1	29.1	29.1	29.1	22.3			20.2	36.56	36.48	36.58	36.57	36.42		
8	31	8	1963	30.0	30.0	29.9	29.6	23.5			23.5	36.60	36.60	36.52	36.57	36.38		
9	2	10	1963	27.5	27.5	27.5	27.5	27.5			27.4	36.40	36.49	36.51	36.42	36.50		
10	31	10	1963	26.2	26.2	26.2	26.2	26.2			26.1	36.68	36.64	36.67	36.63	36.62		
	30	11	1963	22.7	22.7	22.7	22.7	22.7			22.7	36.84	36.73	36.68	36.72	36.79		
	19	12	1963	20.7	20.7	20.7	20.6	20.6			20.6	36.88	36.84	36.80	36.80	36.81		
	26	1	1964	16.7	16.7	16.7	16.6	16.1			16.1	36.55	36.79	36.59	36.64	36.71		
14	23	2	1964	16.5	16.5	16.4	16.4	16.3			16.3	36.79	36.76	36.73	36.65	00.00		
15	18	3	1964	18.2	18.2	18.1	17.6	16.0			16.0	36.72	36.70	36.74	36.68	36.70		
16	15	4	1964	19.5	19.5	19.4	18.7	18.2			18.2	36.68	36.68	36.61	36.76	36.83		
	22	5	1964	25.9	25.8	25.7	23.9	21.1			20.6	33.65	33.62	33.90	36.57	36.62		
	25	6	1964	28.1	28.1	27.9	26.5	21.1			20.5	32.76	32.72	32.97	34.46	36.49		
	16	7	1964	28.7	28.7	28.7	28.4	22.9			20.4	33.76	33.35	33.80	35.72	36.47		
	29	8	1964	29.8	29.8	29.7	29.4	24.3			22.5	34.54	34.50	34.50	36.31	36.43		
21	29	9	1964	28.3	28.3	28.2	28.3	27.3			27.0	35.91	35.84	35.88	35.96	36.26		
22	28	10	1964	24.8	24.8	24.8	24.8	24.8			24.8	36.15	36.11	36.39	36.32	36.46		
23	27	11	1964	23.2	23.2	23.2	23.1	23.1			23.1	36.58	36.65	36.57	36.56	36.55		
	16	12	1964	20.8	20.8	20.8	20.8	20.8			20.8	36.65	36.58	36.62	36.61	36.61		
	7	1	1965	20.6	20.6	20.5	20.4	20.4			20.4	36.69	36.64	36.70	36.71	36.86		
	26	2	1965	18.7	18.7	18.6	18.6	18.5			18.5	36.76	36.69	36.92	36.73	36.73		
27	21	3	1965	17.3	17.3	17.2	17.2	17.2			17.2	36.58	36.47	36.52	36.59	36.59		
28	23	4	1965	22.5	22.5	22.4	19.7	17.6			17.6	36.37	36.32	36.53	36.51	36.58		
32	11	8	1965	29.3	29.3	29.3	28.0	21.3			20.9	34.57	34.70	35.05	36.53	36.53		
	9	9	1965	29.3	29.3	29.3	29.3	23.5			23.4	00.00	00.00	00.00	00.00	00.00		
	9	12	1965	21.8	21.8	21.8	21.7	21.7			21.7	36.00	35.97	35.97	36.00	36.04		

N: W-54
DEPTH: 73 M
LATITUDE: 28°00' N
LONGITUDE: 94°38' W

	31	1	1963	19.2	19.1	18.8	18.4	18.2	17.3		17.2	36.49	36.43	36.41	36.54	36.53	36.57	
	3	3	1963	18.6	18.6	18.5	18.3	17.5	17.4		17.2	36.57	36.51	36.55	36.49	36.54	36.57	
3	3	4	1963	21.6	21.6	21.5	20.0	19.3	18.4		18.1	36.55	36.57	36.61	36.53	36.58	36.50	
4	6	5	1963	24.2	24.1	23.9	23.3	20.5	18.8		18.4	35.71	35.71	35.68	35.52	36.37	36.63	
5	20	5	1963	26.3	26.2	25.7	25.3	20.8	19.3		18.6	32.90	32.93	35.40	36.24	36.41	36.51	
	26	6	1963	28.6	28.6	28.6	28.3	23.8	19.7		19.6	36.46	36.49	36.46	00.00	36.35	36.49	
	17	7	1963	28.8	28.7	28.6	27.8	22.8	19.1		19.1	36.59	36.46	36.50	36.49	36.48	36.42	
	31	8	1963	29.7	29.7	29.6	25.6	21.9	18.3		18.2	36.89	36.90	36.43	36.63	36.31	36.33	
	2	10	1963	27.3	27.3	27.3	27.3	27.3	23.5		21.4	36.59	36.61	36.54	36.58	36.57	36.43	
10	31	10	1963	26.3	26.3	26.3	26.2	26.2	26.1		22.7	36.76	36.63	36.74	36.75	36.69	36.63	
11	30	11	1963	23.3	23.3	23.3	23.3	23.3	23.3		21.4	36.84	36.85	36.83	36.82	36.76	36.81	
12	19	12	1963	21.1	21.1	21.1	21.0	20.9	20.7		20.7	36.77	36.71	36.71	36.70	36.77	36.76	
	26	1	1964	18.3	18.3	18.2	18.2	18.2	17.4		17.3	36.60	36.72	36.64	36.62	36.77	36.62	
	23	2	1964	18.2	18.2	18.2	18.1	17.9	17.1		17.0	36.75	36.65	36.54	36.49	36.70	00.00	
	18	3	1964	19.5	19.5	19.5	19.4	19.3	17.5		17.5	36.59	36.59	36.58	36.58	36.54	36.51	
16	15	4	1964	20.7	20.7	20.6	19.2	18.4	16.8		16.8	36.65	36.62	36.61	36.45	36.66	36.58	
17	22	5	1964	26.1	26.1	26.0	23.9	19.1	17.9		17.9	33.30	33.29	34.34	36.35	36.37	36.54	
18	25	6	1964	28.1	28.1	27.9	27.6	21.6	18.6		18.6	33.26	33.27	33.35	34.62	36.51	36.40	
	16	7	1964	28.7	28.7	28.7	28.4	25.1	20.3		17.5	35.05	35.04	36.02	36.55	36.66	36.62	
	30	8	1964	29.6	29.6	29.4	29.2	24.4	20.1		19.9	36.16	36.05	36.63	36.64	36.72	36.60	
	28	9	1964	28.2	28.2	28.1	28.1	20.7	20.3		20.2	35.97	35.90	35.89	36.20	36.60	36.60	
	28	10	1964	25.4	25.4	25.4	25.3	25.4	21.9		21.9	36.68	36.59	36.62	36.62	36.65	36.60	
23	27	11	1964	23.4	23.4	23.4	23.3	23.3	23.2		23.1	36.80	36.70	36.65	36.66	36.68	36.65	
24	16	12	1964	21.7	21.7	21.7	21.7	21.7	21.7		21.7	36.67	36.66	36.66	36.69	36.68	36.67	
25	7	1	1965	22.1	22.1	22.1	22.0	21.9	21.2		21.1	36.82	36.78	36.80	36.81	36.78	36.76	
	26	2	1965	19.6	19.6	19.4	19.4	19.4	19.3		19.3	36.78	36.69	36.70	36.72	36.68	36.67	
	21	3	1965	17.7	17.7	17.7	17.7	17.7	17.1		17.1	36.32	36.30	36.31	36.26	36.28	36.32	
	23	4	1965	22.5	22.5	22.4	22.3	19.7	17.8		17.7	36.56	36.68	36.66	36.51	36.76	36.51	
29	2	6	1965	26.6	26.6	26.4	24.7	20.6	18.8		18.8	35.58	35.57	35.64	36.54	36.65	36.63	
30	12	6	1965	26.5	26.5	24.7	20.6	19.3	18.9		18.9	35.23	35.45	35.92	36.06	36.58	36.61	
32	11	8	1965	26.7	26.4	24.8	20.8	19.3	19.0		19.0	34.64	35.08	35.19	36.53	36.61	36.69	
	9	12	1965	23.4	23.4	23.3	23.2	23.2	23.1		23.1	00.00	00.00	00.00	00.00	00.00	00.00	

Table 7. (Continued)

STATION: W-6
DEPTH: 110 M
LATITUDE: 27°55' N
LONGITUDE: 94°36' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	31	1	1963	20.3	20.1	19.8	19.6	19.1	19.0	00.0	00.0	36.40	36.42	36.51	36.49	36.45	36.52
2	3	3	1963	19.7	19.7	19.6	19.5	18.9	18.3	17.1	17.1	36.65	36.57	36.62	36.53	36.56	36.57
3	3	4	1963	21.7	21.6	20.4	19.8	19.2	18.7	17.5	17.3	36.50	36.44	36.61	36.49	36.54	36.52
4	6	5	1963	24.1	24.1	24.0	23.4	20.9	19.3	18.8	18.8	35.47	35.34	35.45	35.44	36.41	36.58
5	20	5	1963	26.8	26.4	26.3	26.1	23.6	20.9	20.2	19.9	33.50	35.58	36.00	36.33	36.53	36.51
6	26	6	1963	28.9	28.8	28.7	28.4	24.5	20.9	18.8	18.7	36.88	36.48	36.58	36.54	36.41	36.49
7	16	7	1963	29.1	29.1	28.8	28.7	25.9	18.4	17.8	17.8	36.53	36.36	36.51	36.52	36.47	36.40
8	31	8	1963	29.9	29.8	29.7	25.6	21.7	18.6	16.9	16.9	36.43	36.39	36.42	36.45	36.41	36.28
9	2	10	1963	26.8	26.8	26.7	26.7	26.6	22.1	17.6	17.6	36.50	36.48	36.38	36.39	36.41	36.49
10	31	10	1963	26.3	26.2	26.2	26.1	26.1	23.9	19.9	17.9	36.79	36.62	36.71	36.75	36.67	36.63
11	30	11	1963	23.5	23.5	23.5	23.4	23.4	23.3	19.2	19.1	36.83	36.73	36.78	36.79	36.75	36.72
12	19	12	1963	21.6	21.5	21.4	21.3	21.3	21.2	20.3	17.1	36.70	36.70	36.55	36.71	36.78	36.69
13	26	1	1964	19.4	19.4	19.4	19.3	19.3	19.0	17.8	17.6	36.66	36.62	36.66	36.67	36.62	36.62
14	23	2	1964	18.6	18.6	18.6	18.6	18.5	17.9	17.4	17.4	36.74	36.63	36.65	36.65	36.61	36.70
15	18	3	1964	20.3	20.2	19.8	19.4	19.3	18.9	17.8	17.7	36.72	36.68	36.59	36.65	36.64	36.56
16	15	4	1964	20.8	20.8	20.7	20.4	20.3	18.8	17.1	00.0	36.68	36.65	36.66	36.65	36.74	36.69
17	22	5	1964	25.8	25.7	25.7	23.9	19.7	18.2	17.6	16.8	25.72	34.60	34.74	36.28	36.26	36.41
18	25	6	1964	28.3	28.3	28.3	27.1	21.8	19.0	18.2	17.4	33.51	33.47	32.91	35.77	36.47	36.49
19	16	7	1964	28.6	28.6	28.6	28.3	25.6	20.8	17.4	16.5	36.39	36.38	36.36	36.39	36.71	36.57
20	30	8	1964	29.5	29.5	29.5	29.3	26.3	20.8	18.3	17.9	36.64	36.61	36.63	36.63	36.74	36.63
21	28	9	1964	28.7	28.8	28.7	28.7	28.0	19.3	19.0	18.9	36.18	36.34	36.62	36.64	36.78	36.60
22	29	10	1964	25.7	25.7	25.7	25.7	25.6	21.0	19.1	18.8	36.82	36.81	36.80	36.91	36.88	36.57
23	27	11	1964	23.5	23.5	23.5	23.4	23.4	23.3	18.6	18.3	36.74	36.71	36.72	36.76	36.80	36.77
24	16	12	1964	21.8	21.8	21.8	21.8	21.8	21.8	18.8	18.7	36.82	36.66	36.75	36.67	36.68	36.66
25	7	1	1965	22.2	22.2	22.2	22.1	21.9	21.5	21.1	20.8	36.81	36.78	36.80	36.81	36.78	36.76
26	27	2	1965	19.6	19.7	19.7	19.6	19.3	19.2	18.3	17.8	36.76	36.72	36.79	36.69	36.70	36.73
27	21	3	1965	19.8	19.8	19.8	19.7	19.7	19.7	16.9	16.9	36.83	36.60	36.67	36.68	36.70	36.67
28	23	4	1965	23.3	23.3	23.1	22.5	21.1	18.2	17.4	17.4	36.68	36.47	36.68	36.66	36.78	36.43
29	1	6	1965	26.8	26.8	26.7	24.9	21.1	18.9	18.8	18.8	35.49	35.52	35.46	36.38	36.62	36.59
30	12	6	1965	25.6	24.9	22.2	20.3	18.8	17.9	17.2	17.1	35.00	35.05	35.33	36.57	36.24	34.82
32	11	8	1965	26.6	26.6	25.3	20.8	19.4	17.4	16.7	16.7	35.49	36.03	36.67	35.73	36.52	36.60
35	9	12	1965	23.5	23.5	23.5	23.5	23.5	23.5	19.8	19.6	00.00	00.00	00.00	00.00	00.00	00.00

Table 8. Monthly temperature and salinity observations at stations on transect 8, 1963-1965

STATION: W-56
DEPTH: 7 M
LATITUDE: 28°23' N
LONGITUDE: 96°20' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	8	3	1963	13.9	13.8						13.1	31.72	31.92				
3	7	4	1963	20.8	20.8						20.2	30.38	30.40				
4	3	5	1963	24.5	24.5						24.5	25.61	25.61				
5	22	5	1963	26.4	26.2						26.0	34.87	34.94				
6	27	6	1963	28.7	28.7						28.3	35.70	35.67				
7	16	7	1963	29.2	29.2						24.7	36.80	36.71				
8	28	8	1963	30.2	30.2						30.2	36.88	36.87				
9	5	10	1963	25.8	25.8						25.7	30.17	30.17				
10	4	11	1963	23.0	23.0						22.9	33.84	33.78				
11	1	12	1963	16.7	16.7						18.8	32.74	32.79				
12	20	12	1963	11.1	11.1						10.8	31.81	31.80				
13	30	1	1964	12.2	12.9						11.9	32.29	32.42				
14	19	2	1964	13.4	13.4						13.4	35.44	35.46				
15	21	3	1964	16.1	16.0						15.5	33.37	33.32				
16	18	4	1964	21.0	21.0						21.1	27.12	27.21				
17	25	5	1964	26.7	26.2						25.0	00.00	00.00				
18	27	6	1964	29.2	29.1						28.6	33.57	33.49				
19	19	7	1964	28.6	28.6						28.5	34.53	34.44				
20	1	9	1964	29.3	29.3						29.0	36.85	36.83				
21	25	9	1964	28.3	28.3						28.3	33.35	33.21				
22	31	10	1964	22.7	22.7						22.7	32.83	32.76				
23	26	11	1964	17.7	17.7						17.7	31.73	31.68				
24	18	12	1964	13.9	13.9						13.9	31.12	31.09				
25	10	1	1965	15.7	15.7						15.7	30.56	30.52				
26	1	3	1965	15.9	15.9						15.8	34.53	34.52				
27	25	3	1965	16.5	16.4						15.7	31.10	31.17				
28	26	4	1965	24.4	24.2						23.2	30.81	31.00				
29	29	5	1965	26.8	27.0						27.1	20.15	20.71				
30	14	6	1965	30.0	29.3						26.8	26.21	27.33				
32	14	8	1965	29.3	29.2						28.6	34.78	34.74				
33	12	9	1965	29.3	29.2						29.2	00.00	00.00				
35	12	12	1965	19.1	19.2						19.5	28.93	29.36				

Table 8. (Continued)

STATION: W-13
14 M
UDE: 28°19' N
UDE: 96°21' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M) 0	3	11	24	43	70	107	B	Salinity (o/oo) Depth (M) 0	3	11	24	43	70	107
	8	3	1963	14.1	14.1	12.8					12.8	00.00	32.92	31.75				
3	7	4	1963	20.8	20.8	20.8					19.8	30.71	30.71	00.00				
4	3	5	1963	24.7	24.7	24.7					24.7	25.85	25.88	25.91				
5	22	5	1963	26.2	26.1	23.4					23.1	35.52	35.42	35.72				
	16	7	1963	29.2	29.2	25.0					24.3	36.67	00.00	00.00				
	28	8	1963	30.3	30.3	30.3					30.3	37.03	36.93	36.92				
	5	10	1963	25.9	25.8	26.0					26.3	30.63	30.57	31.71				
	4	11	1963	23.4	23.4	23.3					23.3	33.97	33.94	33.72				
11	1	12	1963	17.4	17.4	19.2					19.3	32.61	32.47	34.05				
12	20	12	1963	13.3	13.3	13.3					13.2	33.06	33.55	33.50				
	30	1	1964	11.1	11.0	10.9					10.9	32.88	32.84	32.82				
	19	2	1964	13.8	13.8	13.8					13.8	35.73	35.67	35.69				
	21	3	1964	16.2	16.0	15.6					15.6	32.88	32.89	32.94				
	18	4	1964	20.8	20.5	19.9					19.1	27.34	27.81	30.92				
17	25	5	1964	00.0	00.0	00.0					00.0	27.17	28.94	31.89				
18	27	6	1964	28.9	28.8	27.9					27.9	33.83	33.80	33.85				
19	19	7	1964	28.2	28.2	28.1					28.1	35.59	35.62	35.58				
	1	9	1964	29.0	29.0	29.0					29.0	36.78	36.77	36.73				
	25	9	1964	28.4	28.3	28.3					28.3	33.28	33.26	33.29				
	31	10	1964	22.6	22.6	22.6					22.6	32.85	32.82	32.81				
	26	11	1964	18.5	18.5	18.8					20.4	32.05	32.16	32.40				
24	18	12	1964	14.4	14.4	14.4					14.4	31.71	31.73	31.77				
25	10	1	1965	15.6	15.6	15.6					15.7	30.53	30.48	30.81				
	1	3	1965	16.2	16.2	16.2					16.3	34.19	34.56	00.00				
	24	3	1965	16.7	16.5	15.6					15.6	31.78	31.87	32.25				
	25	4	1965	24.7	24.3	23.6					23.6	30.98	30.97	31.11				
	29	5	1965	27.0	27.0	26.3					25.5	22.32	22.40	29.40				
30	14	6	1965	30.6	28.0	25.1					25.1	28.08	29.19	33.88				
32	14	8	1965	29.2	29.1	28.9					28.8	34.82	34.86	35.10				
33	12	9	1965	29.2	29.2	29.2					29.1	00.00	00.00	00.00				
	12	12	1965	19.0	19.0	20.2					20.3	28.73	30.44	32.74				

N: W-14
DEPTH: 28 M
LATITUDE: 28°07' N
LONGITUDE: 96°13'30" W

Cruise	Day	Month	Year	Temperature (°C) Depth (M) 0	3	11	24	43	70	107	B	Salinity (o/oo) Depth (M) 0	3	11	24	43	70	107
	8	3	1963	15.6	14.2	14.1	14.7				15.1	00.00	35.70	35.56	35.80			
	4	4	1963	19.5	19.5	19.2	19.7				19.8	33.64	33.81	35.13	36.27			
	2	5	1963	23.6	23.6	23.6	23.6				23.5	33.75	33.84	33.82	34.67			
5	21	5	1963	26.0	26.0	25.4	22.2				20.2	35.15	35.10	35.47	36.07			
6	27	6	1963	27.8	27.7	27.7	24.7				24.7	36.38	36.38	36.40	36.32			
7	16	7	1963	27.8	27.7	27.7	23.9				21.7	36.44	36.45	36.54	36.41			
	30	8	1963	29.3	29.3	29.3	23.9				22.3	37.04	36.68	36.66	36.61			
	3	10	1963	27.5	27.5	27.5	27.5				27.5	36.11	36.04	36.24	36.40			
	1	11	1963	25.6	25.6	25.6	25.6				25.5	36.44	36.32	36.37	36.32			
11	1	12	1963	19.4	19.4	19.6	20.4				20.3	35.54	35.65	35.94	36.14			
12	20	12	1963	18.6	18.6	18.6	18.2				17.9	36.79	36.69	36.71	36.78			
13	28	1	1964	17.4	17.4	17.4	17.3				15.9	36.69	36.63	36.59	36.62			
	19	2	1964	16.1	16.1	16.0	15.9				15.9	36.74	36.78	36.70	36.65			
	22	3	1964	16.8	16.8	16.8	16.8				16.8	36.22	36.18	36.20	36.29			
	16	4	1964	18.8	18.8	18.5	18.2				18.2	35.36	35.46	35.46	36.06			
	23	5	1964	26.3	26.2	25.4	23.6				23.2	26.42	26.48	30.21	35.40			
18	26	6	1964	28.3	28.3	28.2	24.0				23.9	33.57	33.35	33.45	35.79			
19	17	7	1964	27.5	27.5	27.4	21.8				21.8	36.37	36.39	36.33	36.40			
20	30	8	1964	29.3	28.8	28.6	28.1				28.0	36.76	36.69	36.70	36.71			
	28	9	1964	28.4	28.4	28.4	28.3				28.3	35.17	35.16	35.22	35.31			
	29	10	1964	24.0	24.0	24.1	24.3				24.3	35.48	35.52	35.55	35.68			
	26	11	1964	21.6	21.6	21.6	21.6				22.5	35.57	35.49	00.00	35.50			
24	17	12	1964	18.6	18.6	18.6	18.5				18.3	35.34	35.31	35.33	35.24			
25	8	1	1965	16.9	00.0	00.0	00.0				17.4	34.79	34.79	34.80	35.00			
26	27	2	1965	14.7	00.0	00.0	0.00				17.4	31.78	31.53	35.18	36.54			
	22	3	1965	15.7	00.0	00.0	00.0				15.7	35.38	35.34	35.41	35.45			
	24	4	1965	22.0	00.0	00.0	00.0				20.5	35.08	35.05	35.27	35.50			
	29	5	1965	26.1	00.0	00.0	00.0				24.3	31.73	31.20	35.05	26.36			
	13	6	1965	29.1	00.0	00.0	00.0				24.6	27.80	28.03	29.94	35.41			
32	12	8	1965	28.7	00.0	00.0	00.0				27.1	35.60	35.63	35.56	31.35			
33	11	9	1965	29.3	29.2	29.1	28.9				28.9	00.00	00.00	00.00	00.00			
35	10	12	1965	21.3	21.3	21.3	21.2				21.2	34.92	34.87	34.81	34.79			

Table 8. (Continued)

STATION: W-15
DEPTH: 46 M
LATITUDE: 27°57' N
LONGITUDE: 96°07' W

Cruise	Day	Month	Year	Temperature ($^{\circ}C$)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	8	3	1963	16.9	16.9	16.9	15.0	15.6			15.7	36.35	36.22	36.27	36.01	36.28	
3	4	4	1963	22.1	22.1	22.1	21.4	19.1			19.1	36.34	36.36	36.30	36.37	36.44	
4	2	5	1963	23.8	23.8	23.8	21.1	20.3			20.2	35.30	35.21	35.02	36.06	36.02	
5	21	5	1963	26.5	26.4	25.9	22.8	20.0			19.6	32.34	32.49	33.96	35.97	36.55	
6	27	6	1963	28.8	28.6	28.5	24.4	22.2			22.2	36.35	36.37	36.42	36.45	36.42	
7	16	7	1963	28.5	28.5	28.5	28.3	23.3			20.5	36.58	36.53	36.51	36.41	36.47	
8	30	8	1963	28.7	28.6	28.2	25.4	23.1			23.1	36.30	37.04	36.32	36.50	36.54	
9	3	10	1963	27.2	27.2	27.1	27.0	26.9			27.0	36.62	36.50	36.57	36.55	36.54	
10	1	11	1963	26.2	26.2	26.2	26.2	26.2			26.1	36.59	36.63	36.60	36.70	36.72	
11	1	12	1963	22.7	22.7	22.7	22.7	22.7			22.6	36.71	36.68	36.62	36.65	36.69	
12	20	12	1963	20.9	20.9	20.8	20.8	19.8			19.6	36.80	36.69	36.70	36.75	36.88	
13	28	1	1964	18.2	18.2	17.9	17.2	14.3			14.0	36.55	36.56	36.60	36.60	36.27	
14	19	2	1964	17.0	17.0	17.0	16.9	16.4			16.4	36.59	36.75	36.55	36.65	36.63	
15	19	3	1964	16.9	16.9	16.9	16.9	16.9			16.9	36.53	36.40	36.39	36.41	36.59	
16	16	4	1964	19.4	19.4	19.2	18.7	17.9			17.9	34.39	36.11	36.51	36.73	36.70	
17	23	5	1964	25.6	25.4	25.4	22.7	21.1			21.0	31.99	32.20	34.53	35.94	36.20	
18	26	6	1964	28.2	28.1	28.1	25.9	20.7			19.9	33.46	33.44	33.57	34.88	36.50	
19	17	7	1964	28.2	28.2	28.2	27.3	19.4			19.4	36.58	36.50	36.62	36.50	36.65	
20	30	8	1964	29.2	29.0	28.7	28.5	26.2			25.2	36.70	36.60	36.59	36.62	36.46	
21	28	9	1964	28.3	28.3	28.3	28.3	28.2			27.9	35.62	35.60	35.68	35.87	36.27	
22	29	10	1964	24.9	24.9	24.9	24.9	24.9			24.9	36.33	36.33	36.31	36.32	36.33	
23	26	11	1964	22.9	22.9	22.9	22.9	22.9			22.9	36.50	36.50	36.48	36.57	36.48	
24	17	12	1964	20.6	20.6	20.5	20.6	20.4			20.3	36.42	36.57	36.42	36.48	36.51	
25	8	1	1965	20.8	20.8	20.7	20.4	20.3			20.0	36.67	36.68	00.00	36.55	36.51	
26	27	2	1965	18.7	18.7	18.6	18.6	18.6			18.6	36.67	36.64	36.80	36.67	36.68	
27	22	3	1965	17.7	17.7	17.6	17.6	17.6			17.6	36.66	36.09	36.04	36.10	36.13	
28	24	4	1965	23.3	23.2	22.5	21.5	18.9			18.8	35.00	34.80	35.79	36.41	36.33	
29	1	6	1965	26.6	26.6	26.3	25.5	22.3			20.1	33.51	35.31	34.41	35.31	36.62	
30	12	6	1965	30.0	28.2	27.0	26.1	23.8			20.7	30.72	31.03	32.53	35.67	36.59	
32	12	8	1965	28.5	28.5	28.4	28.3	21.3			21.2	36.17	36.19	36.04	36.06	36.59	
33	11	9	1965	29.3	29.3	29.3	29.2	23.8			23.7	00.00	00.00	00.00	00.00	00.00	
35	10	12	1965	22.6	22.6	22.6	22.6	22.6			22.6	00.00	00.00	00.00	00.00	00.00	

STATION: W-57
DEPTH: 73 M
LATITUDE: 27°46' N
LONGITUDE: 96°00' W

Cruise	Day	Month	Year	0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	8	3	1963	18.6	18.6	18.6	18.5	17.9	17.3		16.4	36.61	36.51	36.48	36.42	36.55	36.50
3	4	4	1963	21.6	21.3	21.2	20.6	19.8	18.1		18.1	36.27	36.20	36.28	36.29	36.35	36.63
4	2	5	1963	23.9	23.9	23.9	23.9	21.1	19.6		19.3	35.87	35.87	35.86	35.82	36.31	36.38
5	21	5	1963	26.5	26.3	25.7	23.4	20.7	19.3		19.3	34.25	34.38	34.98	35.90	36.36	36.42
6	26	6	1963	28.6	28.5	28.3	25.6	22.2	19.8		19.6	36.50	36.42	36.52	36.42	36.30	36.44
7	16	7	1963	29.1	29.1	29.0	28.9	22.7	20.0		18.2	36.54	36.48	36.52	36.59	36.48	36.35
8	30	8	1963	29.4	29.4	29.4	29.7	26.4	23.7		22.8	36.84	36.37	36.70	36.51	36.76	36.56
9	2	10	1963	26.9	26.8	26.8	26.7	26.7	21.7		21.5	36.82	36.47	36.42	36.49	00.00	36.48
10	1	11	1963	26.3	26.3	26.3	26.2	26.2	26.1		22.5	36.59	36.63	36.60	36.73	36.64	36.73
11	30	11	1963	23.3	23.3	23.3	23.3	23.3	23.3		23.2	36.80	36.76	36.77	36.82	36.76	36.73
12	20	12	1963	20.8	20.8	20.8	20.8	20.8	19.7		19.6	36.66	36.56	36.75	36.76	36.70	36.71
13	28	1	1964	19.5	19.5	19.4	19.3	18.9	17.2		16.4	36.64	36.66	36.61	36.64	36.51	36.51
14	20	2	1964	18.3	18.3	18.2	17.9	17.0	16.9		16.9	36.71	36.64	36.63	36.56	36.57	36.71
15	19	3	1964	19.5	19.5	19.5	19.4	18.5	16.0		15.8	36.58	36.57	36.59	36.55	36.50	36.57
16	16	4	1964	20.3	20.3	20.2	18.8	18.1	17.1		16.9	36.45	36.29	36.30	36.41	36.68	36.75
17	23	5	1964	24.9	24.9	25.1	22.7	19.4	18.8		18.4	32.05	32.60	33.78	36.16	36.52	36.49
18	25	6	1964	28.4	28.4	28.2	23.8	21.2	19.3		18.9	32.85	33.00	33.18	35.49	36.57	36.54
19	17	7	1964	28.6	28.6	28.6	28.1	26.2	19.0		19.0	36.74	36.72	36.67	36.74	36.64	36.52
20	30	8	1964	28.8	28.7	28.7	28.6	24.3	20.9		20.9	36.70	36.66	36.71	36.70	36.65	36.66
21	28	9	1964	28.3	28.3	28.3	28.3	22.8	21.6		21.6	36.51	36.50	36.52	36.51	36.62	36.58
22	29	10	1964	25.4	25.4	25.4	25.4	25.4	23.6		20.8	36.72	36.68	36.71	36.69	36.70	36.59
23	26	11	1964	23.9	23.9	23.9	23.9	23.9	23.5		23.5	36.64	36.51	36.58	36.48	36.52	36.48
24	17	12	1964	22.2	22.2	22.2	22.2	22.2	21.4		21.4	36.65	36.58	36.66	36.58	36.57	36.58
25	7	1	1965	22.3	22.3	22.2	22.2	22.1	21.8		21.3	36.82	36.79	36.80	36.78	36.80	36.78
26	27	2	1965	18.4	18.4	18.4	18.4	18.4	18.4		18.4	36.59	36.60	36.53	36.58	36.60	36.63
27	22	3	1965	19.6	19.6	19.6	19.5	19.4	19.3		19.3	36.69	36.68	36.67	36.80	36.71	36.77
28	24	4	1965	23.3	23.3	22.7	20.9	19.1	17.5		17.5	35.45	35.41	35.42	36.66	36.52	36.49
29	1	6	1965	26.6	26.6	26.1	23.3	20.6	19.7		18.5	32.78	32.74	33.61	36.48	36.61	36.63
30	12	6	1965	28.6	26.7	25.1	22.9	19.9	19.5		19.6	31.85	32.09	27.43	34.99	36.65	36.39
32	12	8	1965	27.7	27.7	27.2	23.9	21.8	19.9		19.9	36.61	36.66	36.69	36.61	36.72	36.60
33	11	9	1965	29.0	28.9	28.9	26.7	22.8	21.6		21.6	00.00	00.00	00.00	00.00	00.00	00.00
35	10	12	1965	23.2	23.2	23.2	23.2	23.2	23.2		23.3	00.00	00.00	00.00	00.00	00.00	00.00

Table 9. Monthly temperature and salinity observations at stations on transect 9, 1963-1965

ATION: W-59
7 M
E: 27°51' N
DE: 97°01' W

uise	Day	Month	Year	Temperature (°C) Depth (M) 0	3	11	24	43	70	107	B	Salinity (o/oo) Depth (M) 0	3	11	24	43	70	107
2	9	3	1963	15.3	15.3						15.0	32.49	32.53					
3	6	4	1963	23.6	23.6						22.7	29.41	29.30					
4	5	5	1963	25.6	25.6						25.2	27.20	27.20					
5	22	5	1963	24.8	24.4						24.7	36.29	36.23					
	27	6	1963	29.0	29.0						28.9	36.47	36.50					
	16	7	1963	26.2	25.0						28.0	37.02	37.31					
	28	8	1963	30.1	30.1						29.6	36.89	36.89					
9	3	10	1963	26.2	26.2						26.7	30.52	30.40					
10	3	11	1963	23.6	23.6						23.6	34.31	34.30					
11	1	12	1963	17.3	17.3						15.9	32.99	32.98					
	21	12	1963	11.9	11.8						11.8	33.30	33.30					
	30	1	1964	11.6	11.6						11.6	33.12	33.12					
	20	2	1964	13.8	13.8						13.8	35.31	35.41					
15	20	3	1964	17.2	17.1						15.6	34.14	34.15					
16	18	4	1964	21.0	21.0						19.7	27.22	27.31					
17	25	5	1964	00.0	00.0						00.0	25.54	25.60					
	27	6	1964	28.3	28.2						28.3	00.00	35.10					
	18	7	1964	28.5	28.4						28.2	36.04	36.02					
	1	9	1964	29.2	29.2						29.2	36.76	36.76					
	29	9	1964	28.5	28.5						28.6	34.29	34.35					
22	31	10	1964	22.9	22.9						22.7	33.31	33.30					
23	20	11	1964	23.5	23.5						23.5	34.26	34.24					
24	18	12	1964	12.8	12.8						12.8	31.15	31.12					
	9	1	1965	17.0	17.0						16.9	30.89	30.90					
	1	3	1965	16.0	16.0						16.5	34.00	34.08					
	23	3	1965	16.4	16.1						15.3	33.36	33.36					
28	24	4	1965	23.3	23.2						22.7	30.28	30.25					
29	30	5	1965	26.5	26.5						26.4	26.77	26.77					
30	14	6	1965	28.5	28.5						27.2	28.95	28.98					
	12	8	1965	28.8	28.7						28.6	36.62	36.61					
	12	9	1965	29.4	29.4						29.3	00.00	00.00					
	10	12	1965	19.3	19.2						19.1	30.81	30.44					
ATION: W-24 PTH: 14 M ATITUDE: 27°48' N DE: 97°00' W																		
	9	3	1963	14.2	13.9	13.4					13.4	32.90	32.96	33.95				
3	6	4	1963	21.6	21.6	20.9					20.6	30.43	30.48	31.73				
4	3	5	1963	24.6	24.6	24.6					24.6	26.21	27.48	28.15				
5	22	5	1963	25.2	25.0	22.7					22.6	36.40	36.22	35.99				
	27	6	1963	28.8	28.8	28.8					28.7	36.48	36.52	36.58				
	16	7	1963	25.9	25.9	22.8					22.8	36.37	36.39	37.96				
	28	8	1963	29.3	29.3	28.9					28.8	36.54	36.57	36.60				
	3	10	1963	26.0	26.1	26.7					25.5	30.35	30.79	30.09				
10	3	11	1963	23.8	23.7	23.6					23.6	34.82	34.65	34.68				
11	1	12	1963	17.4	17.4	19.4					15.5	00.00	33.12	35.68				
12	21	12	1963	13.0	13.0	13.0					13.0	34.04	34.20	34.15				
	30	1	1964	11.2	11.2	11.2					11.3	33.39	33.38	33.35				
	20	2	1964	14.2	14.2	14.2					14.2	35.68	35.67	35.66				
	20	3	1964	17.1	16.8	15.6					15.6	33.96	34.08	34.67				
16	18	4	1964	21.0	21.0	19.9					19.6	27.48	27.84	28.58				
17	25	5	1964	26.7	26.6	26.6					26.5	26.69	26.66	26.78				
18	27	6	1964	27.8	27.8	28.1					28.6	34.98	34.95	35.59				
	18	7	1964	28.4	28.4	28.4					28.3	35.96	36.07	35.93				
	1	9	1964	28.6	28.6	28.6					28.3	36.75	36.71	36.72				
	25	9	1964	28.2	28.2	28.2					28.3	34.27	34.20	34.42				
22	31	10	1964	22.8	22.8	22.7					22.6	33.39	33.44	33.38				
23	20	11	1964	23.9	23.9	23.9					23.9	33.89	33.91	33.88				
24	18	12	1964	14.8	14.7	14.7					14.7	31.68	31.64	31.65				
25	9	1	1965	16.4	16.4	15.7					15.7	30.33	31.20	32.59				
	1	3	1965	16.7	16.6	16.5					16.5	34.52	34.53	34.90				
	23	3	1965	16.1	15.6	15.1					15.0	33.59	33.58	33.58				
	24	4	1965	24.3	23.5	22.7					22.7	29.07	30.48	31.47				
29	30	5	1965	26.8	26.8	26.7					26.7	26.32	26.32	26.33				
30	14	6	1965	28.6	28.6	27.0					26.3	30.15	30.23	32.23				
32	12	8	1965	28.7	28.6	28.4					28.4	36.50	36.38	36.34				
	12	9	1965	29.4	29.4	29.3					29.3	00.00	00.00	00.00				
	10	12	1965	19.5	19.5	19.4					19.4	30.66	30.68	30.86				

Table 9. (Continued)

STATION: W-23
DEPTH: 28 M
LATITUDE: 27°35'30" N
LONGITUDE: 96°55' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	9	3	1963	15.6	15.6	15.6	15.3				15.3	34.49	34.71	35.79	35.66		
3	4	4	1963	22.4	22.3	20.4	18.3				17.7	29.42	29.52	35.34	35.90		
4	5	5	1963	24.8	24.8	24.4	23.9				22.9	32.63	32.73	32.73	31.12		
5	21	5	1963	25.8	25.4	24.4	19.4				19.3	36.02	36.05	36.15	36.36		
6	27	6	1963	27.8	27.8	23.9	23.8				23.8	36.52	36.49	36.40	36.49		
7	16	7	1963	27.6	27.5	27.4	23.1				23.1	36.46	36.43	36.40	36.42		
8	30	8	1963	29.1	29.1	29.0	22.4				22.3	36.52	36.90	36.47	36.60		
9	5	10	1963	26.3	26.7	26.9	27.0				27.0	33.09	33.45	34.45	34.80		
10	1	11	1963	25.5	25.5	25.5	25.5				25.4	36.18	00.00	00.00	00.00		
11	2	12	1963	21.2	21.2	21.2	21.2				21.3	36.39	36.29	36.32	36.38		
12	21	12	1963	16.8	16.8	16.8	16.8				16.6	36.10	36.19	36.14	36.10		
13	30	1	1964	16.0	16.0	16.0	15.8				15.4	36.00	35.97	35.95	35.94		
14	20	2	1964	15.2	15.2	15.1	15.2				15.2	35.70	35.76	35.74	35.75		
15	19	3	1964	16.8	16.8	16.8	16.8				16.8	35.60	35.74	36.16	36.21		
16	16	4	1964	19.3	19.3	19.0	17.7				17.5	29.63	29.64	31.05	33.93		
17	24	5	1964	25.3	25.3	25.4	25.0				24.4	00.00	00.00	00.00	00.00		
18	26	6	1964	27.8	27.7	27.4	25.6				25.0	33.86	33.83	34.13	35.19		
19	17	7	1964	27.6	27.6	27.2	21.6				21.5	36.68	36.64	36.62	36.51		
20	31	8	1964	28.4	28.4	28.3	28.1				27.2	36.72	36.68	36.67	36.71		
21	26	9	1964	28.7	28.4	28.5	28.4				28.5	34.38	34.34	35.48	35.42		
22	29	10	1964	23.7	23.6	23.5	00.0				00.0	34.40	34.38	34.78	35.04		
23	24	11	1964	21.9	21.9	21.9	21.9				21.9	35.15	35.11	35.13	35.15		
24	17	12	1964	17.3	17.9	18.5	18.7				18.8	32.70	34.78	34.88	35.57		
25	8	1	1965	16.9	16.9	19.8	20.5				20.3	34.15	34.01	35.38	36.32		
26	28	2	1965	15.3	15.3	16.7	17.8				17.6	31.77	31.72	35.78	36.40		
27	22	3	1965	16.0	16.0	16.0	15.9				15.9	35.39	35.32	35.27	35.32		
28	24	4	1965	24.0	23.2	20.3	19.9				19.8	00.00	00.00	00.00	00.00		
29	30	5	1965	26.6	26.6	26.5	25.6				25.2	00.00	35.27	29.65	31.52		
30	13	6	1965	27.5	27.5	27.5	25.7				24.1	30.85	30.86	31.33	34.20		
32	13	8	1965	28.4	28.4	28.3	28.2				28.2	36.52	36.48	36.56	36.61		
33	12	9	1965	29.3	29.2	28.7	28.6				28.6	00.00	00.00	00.00	00.00		
35	11	12	1965	20.2	20.5	21.2	21.3				21.2	31.89	31.82	33.91	34.00		

STATION: W-22
DEPTH: 46 M
LATITUDE: 27°21' N
LONGITUDE: 96°50' W

2	9	3	1963	16.9	16.9	17.0	16.9	14.5			14.5	36.39	36.44	36.42	36.46	36.19	
3	4	4	1963	23.6	22.8	21.1	20.2	19.6			19.5	31.61	33.85	35.97	36.35	36.43	
4	6	5	1963	24.6	24.5	24.1	21.1	20.3			19.7	34.74	33.88	35.60	35.98	36.25	
5	21	5	1963	26.3	25.7	25.4	20.9	19.4			19.4	36.31	36.32	36.39	36.38	36.40	
6	27	6	1963	27.2	26.2	26.0	22.6	19.8			19.7	36.57	36.34	36.51	36.53	36.43	
7	15	7	1963	27.2	27.1	26.9	24.1	20.8			20.7	36.48	36.51	36.45	36.48	36.49	
8	30	8	1963	28.8	28.8	26.7	24.2	21.7			21.7	36.42	36.28	36.32	36.35	36.57	
9	4	10	1963	26.9	27.0	27.1	27.6	27.2			26.8	35.42	35.26	35.51	36.12	36.32	
10	4	11	1963	25.7	25.7	25.7	25.6	25.6			25.6	36.54	36.47	36.52	36.52	36.50	
11	2	12	1963	22.6	22.6	22.6	22.6	22.6			22.5	36.50	36.59	36.45	36.54	36.56	
12	21	12	1963	18.7	18.7	18.5	18.1	17.4			17.1	36.60	36.59	36.59	36.62	36.30	
13	29	1	1964	16.3	16.3	16.3	18.1	16.2			16.1	35.74	35.74	35.89	36.63	36.39	
14	20	2	1964	17.3	17.3	17.3	17.3	17.3			17.2	36.62	36.59	36.55	36.63	36.56	
15	19	3	1964	18.4	18.2	17.8	17.4	17.3			17.3	36.39	36.38	36.30	36.35	36.27	
16	16	4	1964	17.9	18.4	19.2	18.2	17.7			17.7	33.18	33.13	35.80	36.45	36.41	
17	24	5	1964	25.4	25.4	25.4	23.9	21.7			20.5	31.70	31.90	33.58	35.63	36.30	
18	26	6	1964	28.2	28.2	27.9	25.8	20.3			19.0	33.73	33.71	34.66	36.00	36.46	
19	17	7	1964	27.5	27.5	27.4	22.2	19.2			19.2	36.72	36.66	36.81	36.64	36.79	
20	31	8	1964	28.7	28.7	28.5	28.3	27.7			22.8	36.78	36.69	36.63	36.70	36.62	
21	26	9	1964	28.4	28.3	28.2	28.1	27.3			25.2	36.32	36.32	36.61	36.66	36.62	
22	29	10	1964	25.4	25.4	25.4	25.2	25.1			25.2	36.40	36.18	36.29	36.31	36.32	
23	24	11	1964	23.5	23.5	23.5	23.5	23.5			23.5	36.18	36.18	36.15	36.18	36.18	
24	17	12	1964	20.2	20.2	20.1	19.9	20.5			20.2	36.12	36.12	36.04	36.03	36.26	
25	8	1	1965	20.8	20.8	20.7	20.7	21.0			21.0	36.28	36.21	36.23	36.32	36.61	
26	28	2	1965	16.5	16.5	16.7	17.9	18.1			18.0	34.43	34.36	36.27	35.80	36.40	
27	22	3	1965	17.7	17.7	17.6	17.4	17.8			17.8	35.86	35.92	35.88	35.82	36.06	
28	24	4	1965	24.9	24.7	22.0	18.1	17.6			17.6	00.00	00.00	00.00	00.00	00.00	
29	30	5	1965	26.5	26.5	26.4	25.3	23.1			22.8	29.85	29.93	30.30	34.92	36.54	
30	13	6	1965	27.9	27.9	27.7	25.5	22.3			20.9	30.57	30.58	30.93	35.00	36.50	
32	13	8	1965	28.2	28.1	28.0	27.9	24.2			22.3	36.63	36.62	36.57	36.59	36.69	
33	11	9	1965	30.1	30.1	29.9	29.5	22.6			22.6	00.00	00.00	00.00	00.00	00.00	
35	11	12	1965	21.7	21.8	21.8	22.8	23.5			23.5	34.22	34.23	34.25	34.99	35.57	

Table 9. (Continued)

: W-58
73 M
E: 27°06' N
DE: 96°45' W

Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
			Depth (M)								Depth (M)						
			0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
9	3	1963	18.1	17.8	17.8	17.8	17.8	16.6		16.5	36.41	36.31	36.27	36.27	36.38	36.45	
5	4	1963	22.2	21.4	20.5	19.4	17.9	17.9		17.9	33.24	33.20	35.30	36.27	36.41	36.37	
6	5	1963	23.9	18.3	18.2	21.2	19.7	18.6		18.5	35.87	35.79	36.14	36.25	36.27	36.42	
22	5	1963	26.5	26.4	25.9	25.0	20.1	19.1		18.8	36.12	00.00	36.04	36.13	36.23	36.45	
28	6	1963	28.4	28.3	28.2	23.1	21.7	19.4		19.4	36.51	36.46	36.44	36.46	36.59	36.40	
15	7	1963	27.6	27.6	27.6	25.9	21.5	19.1		18.8	36.58	36.44	36.50	36.42	36.44	36.57	
29	8	1963	28.5	28.4	28.0	22.6	21.6	19.6		19.6	36.28	36.32	36.34	36.42	36.50	36.40	
4	10	1963	27.3	27.3	27.3	27.3	27.1	26.1		24.3	36.47	36.55	36.44	36.47	36.55	36.60	
4	11	1963	25.9	25.9	25.9	25.9	25.8	25.8		22.7	36.67	36.68	36.62	36.66	36.64	36.75	
2	12	1963	23.1	23.1	23.1	23.0	22.9	22.7		22.9	36.38	36.39	36.45	36.38	36.34	36.32	
22	12	1963	21.7	21.7	21.7	21.7	21.6	19.1		18.9	36.64	36.64	36.64	36.68	36.61	36.54	
29	1	1964	19.1	19.1	19.0	18.2	17.4	15.6		14.8	36.54	36.69	36.58	36.50	36.48	36.28	
20	2	1964	19.3	19.2	19.2	19.1	17.8	16.6		16.6	36.66	36.58	36.60	36.56	36.48	36.41	
19	3	1964	19.0	18.7	18.2	17.7	17.1	17.3		17.3	36.41	36.42	36.39	36.38	36.40	36.52	
17	4	1964	20.8	20.6	19.2	18.7	17.9	17.8		17.8	34.24	34.18	36.49	36.46	36.47	36.90	
24	5	1964	25.4	25.4	25.7	22.8	20.0	18.3		18.1	29.68	29.95	32.66	35.98	36.21	36.49	
26	6	1964	28.3	28.1	27.4	22.6	19.6	18.5		18.5	35.28	35.03	35.60	36.36	36.41	36.51	
18	7	1964	28.4	28.4	28.3	27.6	22.1	18.2		18.2	36.71	36.78	36.64	36.60	36.62	36.55	
31	8	1964	29.0	28.9	28.9	28.6	23.8	20.6		20.6	36.73	36.66	36.65	36.69	36.64	36.55	
26	9	1964	28.4	28.4	28.4	28.4	27.2	21.8		21.8	36.52	36.49	36.40	36.66	36.65	36.68	
30	10	1964	25.5	25.5	25.5	25.6	26.0	25.8		25.8	00.00	00.00	36.41	36.52	36.80	36.75	
24	11	1964	23.8	23.8	23.8	23.8	23.8	23.8		23.8	36.62	36.55	36.56	36.49	36.57	36.55	
17	12	1964	20.9	20.9	20.7	20.7	20.7	20.7		20.7	36.14	36.15	36.13	36.22	36.21	36.27	
8	1	1965	20.7	20.7	20.6	20.6	20.5	20.1		20.0	36.09	36.10	36.13	36.11	36.40	36.42	
28	2	1965	19.5	19.5	19.4	19.4	19.4	17.5		17.6	36.58	36.49	36.56	36.51	36.36	35.40	
22	3	1965	19.4	19.4	19.3	19.2	19.2	19.2		19.2	36.43	36.41	36.40	36.47	36.48	36.59	
24	4	1965	24.6	24.4	18.1	17.2	16.8	17.2		17.2	29.52	29.90	33.27	35.97	36.39	36.47	
30	5	1965	27.1	27.1	26.4	21.8	20.0	18.9		18.8	28.68	28.68	29.42	36.04	36.48	36.47	
13	6	1965	27.5	26.9	25.0	21.9	19.2	18.9		18.9	31.81	31.80	32.04	34.98	36.48	36.48	
13	8	1965	27.6	27.5	26.6	23.6	22.1	19.4		19.4	36.53	36.50	36.50	36.62	36.64	36.66	
11	9	1965	30.1	30.1	30.1	27.9	22.7	00.0		22.4	00.00	00.00	00.00	00.00	00.00	00.00	
11	12	1965	23.6	23.6	23.7	23.7	23.7	23.7		23.7	36.15	36.13	36.15	36.42	36.13	36.11	

Table 10. Monthly temperature and salinity observations at stations on transect 10, 1963-1965

: W-60
7 M
E: 26°34' N
DE: 97°16' W

Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
			Depth (M)								Depth (M)						
			0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
9	3	1963	15.3	14.9						14.9	34.27	34.15					
28	6	1963	26.3	26.3						24.0	36.41	36.32					
15	7	1963	25.1	23.9						22.8	36.49	36.44					
29	8	1963	27.6	27.6						24.9	36.47	36.62					
4	10	1963	26.2	26.2						26.3	31.77	32.13					
3	11	1963	23.5	23.5						23.5	33.95	33.81					
2	12	1963	19.8	19.8						19.7	34.42	34.62					
22	12	1963	12.2	12.2						12.2	34.25	34.35					
30	1	1964	14.2	14.2						14.2	34.08	34.05					
20	3	1964	17.8	17.8						16.8	35.42	35.42					
17	4	1964	20.7	20.7						20.4	31.86	31.80					
24	5	1964	26.1	26.1						24.7	28.16	28.15					
27	6	1964	27.4	27.4						27.4	35.49	35.45					
18	7	1964	27.1	27.1						26.9	36.40	36.46					
31	8	1964	27.3	26.0						24.6	36.73	36.70					
26	9	1964	28.8	28.8						28.8	00.00	36.93					
30	10	1964	24.0	24.0						24.0	34.45	34.43					
24	11	1964	19.9	19.9						19.9	33.88	33.85					
18	12	1964	15.2	15.2						15.2	32.09	32.05					
9	1	1965	16.9	16.9						16.1	32.67	32.66					
28	2	1965	17.2	17.2						17.5	34.90	35.00					
23	3	1965	16.7	16.7						16.2	34.32	34.39					
25	4	1965	24.0	24.0						23.3	29.72	29.72					
31	5	1965	26.2	26.2						26.2	33.20	33.21					
14	6	1965	27.2	27.2						27.0	34.21	34.37					
14	8	1965	28.0	28.0						27.9	36.65	36.62					
11	12	1965	20.1	20.1						20.0	31.76	31.73					

Table 10. (Continued)

STATION: W-61
DEPTH: 23 M
LATITUDE: 26°36' N
LONGITUDE: 97°08' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	10	3	1963	14.5	14.5	13.7					15.1	33.78	33.73	34.13			
3	5	4	1963	21.9	21.8	21.7					18.3	31.23	31.22	31.29			
6	28	6	1963	27.2	27.2	22.1					21.8	36.39	36.42	36.40			
7	15	7	1963	25.5	25.3	23.3					22.2	36.90	00.00	00.00			
8	29	8	1963	28.2	28.0	26.7					23.6	36.61	36.52	36.56			
9	4	10	1963	26.7	26.7	26.8					28.1	31.95	31.96	32.29			
10	4	11	1963	24.4	24.4	24.4					24.3	34.80	34.63	34.72			
11	2	12	1963	18.6	18.7	20.3					20.6	33.17	33.11	34.75			
12	22	12	1963	15.2	15.2	15.2					15.0	35.29	35.31	35.25			
13	29	1	1964	12.4	12.3	12.3					12.2	33.96	33.91	33.91			
15	20	3	1964	17.1	16.6	16.5					16.4	36.72	35.41	35.53			
16	17	4	1964	19.8	19.8	19.7					19.5	00.00	00.00	00.00			
17	24	5	1964	25.6	25.5	25.1					22.9	27.49	27.42	28.69			
18	27	6	1964	26.7	26.4	24.1					23.9	35.88	35.90	35.98			
19	18	7	1964	25.4	25.4	24.3					23.2	36.47	36.49	36.45			
20	31	8	1964	28.3	27.5	26.3					23.4	36.69	36.66	36.65			
21	26	9	1964	00.0	00.0	00.0					00.0	36.48	36.42	36.50			
22	30	10	1964	24.0	24.0	23.9					23.9	34.53	34.55	34.50			
23	24	11	1964	21.6	21.6	21.6					21.7	34.46	34.42	34.50			
24	17	12	1964	16.0	16.0	16.2					16.7	32.59	32.59	33.09			
25	9	1	1965	16.8	16.7	16.4					17.4	32.48	32.45	33.35			
26	28	2	1965	15.5	15.5	16.1					16.2	33.09	33.15	34.59			
27	23	3	1965	16.7	16.6	16.6					16.6	34.65	34.63	34.81			
28	25	4	1965	23.8	23.8	23.5					18.7	29.29	29.22	29.79			
29	31	5	1965	26.1	26.0	26.0					25.0	33.18	33.18	33.27			
30	14	6	1965	27.9	27.9	26.3					25.7	32.71	32.73	33.81			
32	14	8	1965	27.7	27.6	27.5					27.3	36.50	36.63	36.58			
35	11	12	1965	20.0	19.9	20.4					21.4	31.55	31.53	31.53			

STATION: W-62
DEPTH: 46 M
LATITUDE: 26°41' N
LONGITUDE: 96°53' W

2	10	3	1963	18.2	18.1	18.1	16.8	16.6			16.6	36.09	36.43	36.41	36.41	36.38	
3	5	4	1963	00.0	00.0	00.0	00.0	00.0			00.0	33.39	33.41	36.26	35.96	36.52	
6	28	6	1963	27.3	27.2	26.4	21.4	19.8			19.8	36.45	00.00	00.00	00.00	36.30	
7	15	7	1963	27.0	27.0	26.9	24.0	20.8			20.4	36.48	36.47	36.37	36.48	36.45	
8	29	8	1963	29.3	29.2	29.1	24.1	21.4			21.3	36.67	36.63	36.64	36.43	36.33	
9	4	10	1963	27.9	27.9	27.9	27.9	27.6			25.6	36.27	36.35	36.41	36.46	36.48	
10	4	11	1963	25.6	25.6	25.7	25.7	25.7			25.7	36.34	36.32	36.36	36.33	36.52	
11	2	12	1963	22.8	22.8	22.8	22.8	22.8			23.6	36.05	36.05	35.94	35.88	36.13	
12	22	12	1963	19.8	19.8	19.3	18.7	18.6			18.4	36.69	36.62	36.60	36.66	36.63	
13	29	1	1964	16.7	16.7	16.7	16.8	16.4			16.4	36.24	36.27	36.24	36.31	36.62	
15	20	3	1964	14.6	14.5	14.4	14.3	00.0			13.2	36.56	36.49	36.48	36.49	36.49	
16	17	4	1964	20.6	20.6	19.3	20.3	17.9			17.9	32.30	32.23	35.88	36.71	36.50	
17	24	5	1964	25.8	25.7	25.1	22.9	20.3			19.7	27.12	26.91	33.32	36.00	36.57	
18	26	6	1964	27.7	27.7	27.4	22.2	20.3			20.2	35.46	35.59	35.53	36.32	36.48	
19	18	7	1964	27.4	27.3	23.6	21.5	19.1			19.1	36.58	36.55	36.62	36.61	36.54	
20	31	8	1964	27.8	27.7	27.6	24.4	21.9			21.9	36.70	36.71	36.71	36.63	36.63	
21	26	9	1964	28.8	28.8	28.8	28.8	28.9			28.9	36.15	36.18	36.32	36.16	36.30	
22	30	10	1964	24.6	24.7	24.7	24.8	25.0			25.0	35.50	35.72	36.05	35.99	35.76	
23	24	11	1964	23.4	23.4	23.4	23.6	23.6			23.7	35.92	35.87	35.80	36.09	35.93	
24	17	12	1964	20.3	20.2	20.3	21.0	21.1			21.1	35.68	35.77	35.89	36.17	36.22	
25	9	1	1965	18.2	18.2	17.6	19.5	20.0			20.0	34.27	34.26	34.90	35.96	36.12	
26	28	2	1965	15.5	15.5	16.4	18.2	18.0			17.9	32.19	32.15	34.88	36.03	32.71	
27	23	3	1965	16.9	16.9	16.8	17.6	17.8			17.8	35.08	35.07	35.16	35.61	35.86	
28	25	4	1965	24.4	24.3	21.5	18.2	17.9			17.8	28.47	28.42	32.51	36.09	32.02	
29	31	5	1965	26.5	26.4	26.0	24.2	23.0			23.0	33.06	33.03	33.98	35.12	36.22	
30	13	6	1965	27.9	27.8	26.6	24.1	22.5			22.3	33.02	34.37	35.33	36.10	36.50	
32	13	8	1965	28.2	27.9	27.9	26.5	23.7			23.6	36.50	36.49	36.48	36.53	36.67	
35	11	12	1965	20.4	20.4	22.6	23.3	00.0			23.2	32.61	32.12	34.74	35.17	35.68	

☆ U. S. GOVERNMENT PRINTING OFFICE: 1977—797-030/ 7

NOAA Technical Report NMFS SSRF-707

Monthly Temperature and Salinity Measurements of Continental Shelf Waters of the Northwestern Gulf of Mexico, 1963-65

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February 1977

U.S. DEPARTMENT OF COMMERCE
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Monthly Temperature and Salinity Measurements of Continental Shelf Waters of the Northwestern Gulf of Mexico, 1963-65[1]

ROBERT F. TEMPLE,[2] DAVID L. HARRINGTON,[3] and JOHN A. MARTIN[2]

ABSTRACT

Temperature and salinity observations made monthly from January 1963 to December 1965 at 48 stations in the northwestern Gulf of Mexico are presented. Off the coasts of Louisiana and Texas monthly average temperatures of surface and bottom waters at station depths of 7, 14, 28, 46,and 73 m exhibited seasonal trends that were similar over a 3-yr period. Monthly average temperatures of surface and bottom waters were generally similar at station depths of 7 and 14 m, but differences were noted at station depths of 28, 46, and 73 m and increased with depth. Maximum average temperatures of bottom waters at station depths generally greater than 14 m occurred after surface temperatures had passed their maximum and were dropping.

Salinities of surface and bottom waters varied markedly at 7- and 14-m stations, whereas at deeper stations seasonal fluctuations were restricted primarily to surface waters. The magnitude of yearly salinity fluctuations decreased with an increase in distance offshore. The effects of the seasonal freshwater inflow of the Mississippi River and other Louisiana rivers on salinities were clearly apparent in Louisiana and Texas offshore waters, although in the latter case there may have been a 1- or 2-mo lag.

INTRODUCTION

etween 1962 and 1965 the Galveston Laboratory of ational Marine Fisheries Service, formerly the u of Commercial Fisheries, conducted an inten- survey of the waters over the continental shelf of the hwestern Gulf of Mexico. This survey was designed ily to provide biological information on shrimp uhn 1963; Temple and Fischer 1965 and 1967; her et al. 1972; and Temple 1973) and finfish (Moore . 1970), but hydrographic data also were collected the study to provide information essential for a complete understanding of the environment over continental shelf.

drographic studies have been conducted periodical- ughout the offshore waters of the Gulf of Mexico e past 35 yr, but these studies generally have been er 1) extensive efforts covering large geographical of the Gulf on a seasonal or sporadic basis, or, 2) in- e efforts investigating specific phenomena over a cted geographical area. Studies in the first category de those reported by Collier 1958; Ichiye 1962; Arm- and Grady 1967 and 1968; and Nowlin and McLel- 67. Those in the second category include inves- tions reported by Gunter 1945; Marvin 1955; Drummond and Austin 1958; Curl 1959; Finucane and Dragovich 1959; Wennekens 1959; Dragovich 1961 and 1963; Dragovich et al. 1961 and 1963; Jones et al. 1965; Stevenson and Leipper 1967; Armstrong 1967 and 1969; Armstrong et al. 1967; and Nowlin and Parker 1974. Additional general information is provided by Fuglister 1947; Leipper 1954; and U.S. Naval Oceanographic Office 1972.

The temperature and salinity information presented in this report adds to the hydrographic data base for the Gulf of Mexico, and is unique in several respects. First, measurements were made generally on a monthly basis at specified locations in the northwestern Gulf of Mexico over a 3-yr period, thus providing a time series heretofore unavailable. Second, these measurements were restricted to a portion of the U.S. continental shelf that is noted for its valuable shrimp and mineral resources which must receive adequate consideration in extended jurisdiction and coastal zone management.

PROCEDURES

Between January 1963 and December 1965, 35 cruises were conducted in continental shelf waters with the 27-m chartered shrimp trawler MV *Gus III*. Observations were made monthly at stations positioned on eight transects located west of the mouth of the Mississippi River and extending to just north of the Mexico-U.S. border (Fig. 1). Stations on two additional transects east of the Mississippi River were occupied only in 1963 during every other month beginning in February. Along each transect stations were positioned in predetermined total

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compilation and tabulation of part of the data reported herein pported under the Department of Interior's Bureau of Land Man- ent Interagency Agreement #08550-1A5-19.

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ne Resources Extension Service, P.O. Box 517, Brunswick, GA

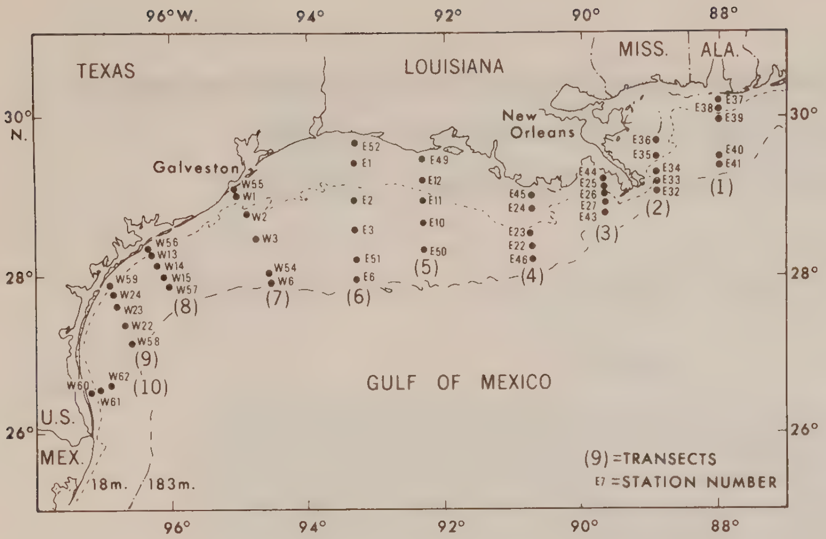


Figure 1.—Transects with stations
during the National Marine Fisheries
investigation of the continental shelf
the northwestern Gulf of Mexico, 19

water depths recorded originally in fathoms but converted herein to the nearest meter. Operations were conducted around the clock, and the time required to complete a cruise ranged from 10 to 24 days; the average cruise was completed in 14 days. Occasionally some stations could not be occupied because of adverse weather conditions or mechanical breakdowns.

Temperatures were measured with mechanical bathythermographs that were allowed to sound bottom on all casts. Surface bucket temperatures were taken for correction purposes with stem thermometers graduated to 0.1°C. In the laboratory, temperature and depth corrections were calculated for each slide before photography, and bathythermogram profiles were aligned by the average correction process as outlined by LaFond (1951). For tabulation purposes, temperatures at a station were recorded at 0 (surface), 3, 11, 24, 43, 70, 107, and B (bottom) meters, depending on total water depth.

Samples of surface water for salinity determinations were obtained from the bucket samples used for bathythermograph reference temperatures. Samples of subsurface waters were taken at depths of 3, 11, 24, 43, 70, and 107 m with Nansen bottles. The deepest sample at any station was 3 m above the bottom. Depths were determined from the wire angles and precalculated length-of-wire tables. Regardless of the method of collection, all samples were drawn into 200-ml culture tubes with Polyseal caps. Chlorinity was determined in the laboratory by the Knudsen method as soon as possible after each cruise.

All temperature and salinity values obtained at each station during this survey are listed by station and grouped by transects in Tables 1-10.

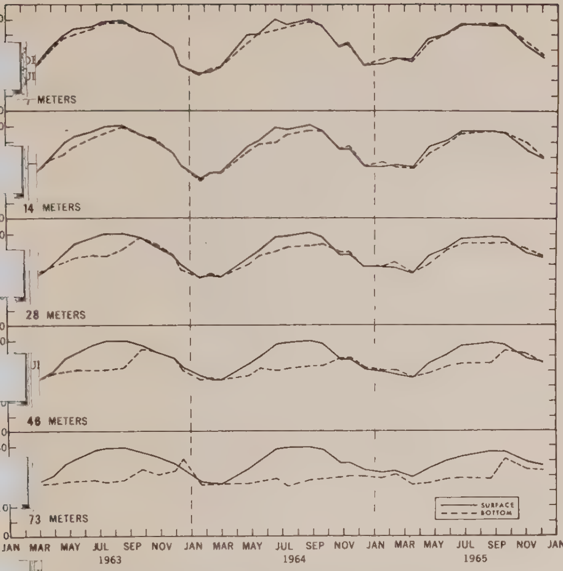
RESULTS

Temperatures and salinities of waters over the continental shelf of the Gulf of Mexico are affected by a number of factors such as air temperatures, winds, oceanic currents, and freshwater inflow. C one significant factor in the area under consider the discharge from the Mississippi River whicl more pronounced or immediate effect on wa Louisiana than on those off Texas. For this reas because State agencies in Louisiana and Texas a cerned with natural resources off their respective the data have been grouped for 1) Louisiana (Tables 3-6), and 2) Texas waters (Tables 7-10 generated from east of the Mississippi River (Tab and from 110 m of water (Table 6, Station E6 an 7, Station W6) are listed for informational purpos

Louisiana Offshore Waters

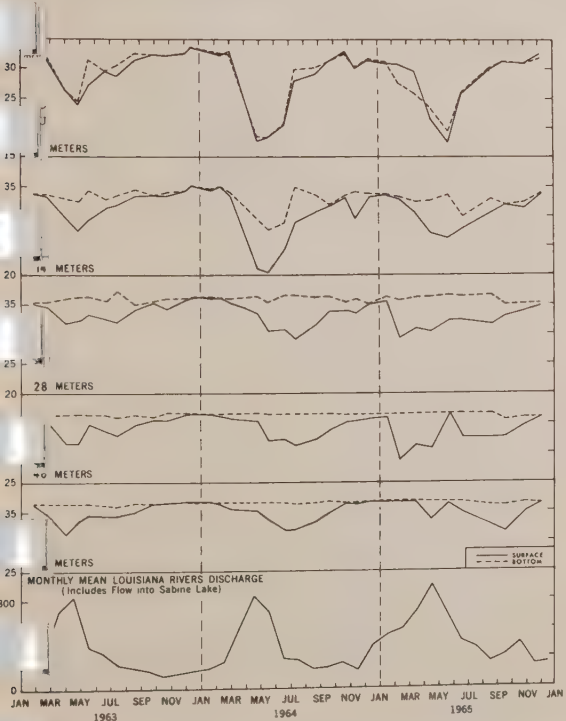
Monthly average surface and bottom tempe (averaged for observations at stations of like depths) over the 3-yr period are plotted for fiv zones in Figure 2. Within each depth zone, the were similar between years, and differences b depths were consistent. Surface and bottom wat peratures closely approximated one another at stations, but the yearly range from a low of about to the high of 30.5°C was greater at this depth tha at the deeper zones. As depth increased, the diff between surface and bottom temperatures increa were greatest at the 73-m stations. Surfac peratures at all stations generally dropped during and winter, warmed during the spring, and a highest values in the summer. Bottom tempera depths greater than 7 m, however, only approx this general cycle inasmuch as highest values fre occurred when surface waters were cooling. This w ticularly pronounced at the two deepest (46 to zones.

Monthly average surface and near-bottom sa for five depth zones are presented in Figure 3. A



2.—Temperature trends of surface and bottom waters over the continental shelf off Louisiana, 1963-65.

:d is the monthly discharge of fresh water from the ssippi River and other Louisiana rivers. Trends in alinities were generally similar between years at the espective depths, but differences did exist between hs. At the 7-m stations, surface salinities generally eir ted near-bottom conditions with values ranging rom a low of 16.5‰ to a high of 33.7‰. Annual variations decreased with increasing depth and distance offshore, with near-bottom salinities being virtually invariant at the 46- and 73-m depth zones. The effects and extent of the seasonal discharge of fresh water from the Mississippi River on offshore salinity values were readily apparent over the entire continental shelf off Louisiana.



.—Salinity trends in surface and bottom waters over the continental shelf off Louisiana, 1963-65.

Texas Offshore Waters

Trends in monthly average temperatures of surface and bottom waters at five depth zones are illustrated in Figure 4. Similar trends were apparent each year, but as in Louisiana waters, differences did occur with increased distance offshore or total depth. Monthly average temperatures of surface and bottom waters at depths of 7 and 14 m were generally similar over the 3-yr period, ranging from a low of about 10.5°C in February 1963 to a high of 30°C in September 1963. Temperature ranges of both surface and bottom waters decreased offshore and with increasing depth. Also, differences between surface and bottom measurements, when they occurred, were more pronounced in the deep waters than in the shallow waters. At depths of 28 m or greater, average monthly values revealed that maximum bottom temperatures occurred generally during a time when temperatures of surface waters were decreasing.

Yearly trends in monthly average salinity values of surface and near-bottom waters off Texas (Fig. 5) were more pronounced at station depths of 7 and 14 m than at the deeper stations (28, 46, and 73 m). Seasonal variations in salinities of surface and near-bottom waters were generally similar out to a depth of 28 m, but beyond that depth near-bottom salinities exhibited little seasonal change. Marked decreases in salinity values, either in surface and/or bottom waters, were related to

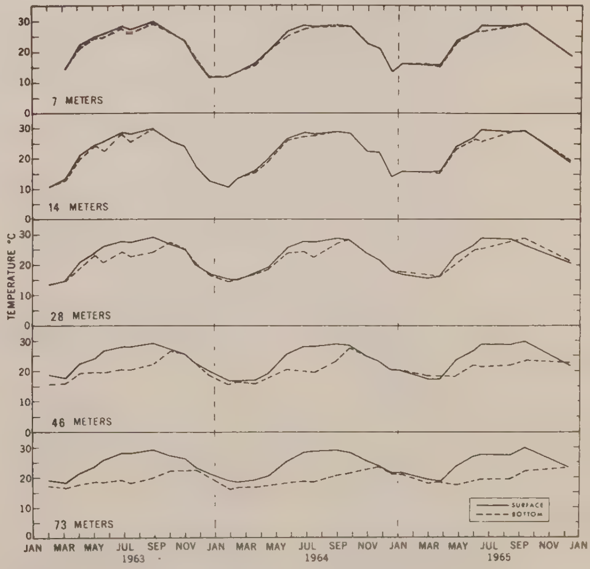


Figure 4.—Temperature trends of surface and bottom waters over the continental shelf off Texas, 1963-65.

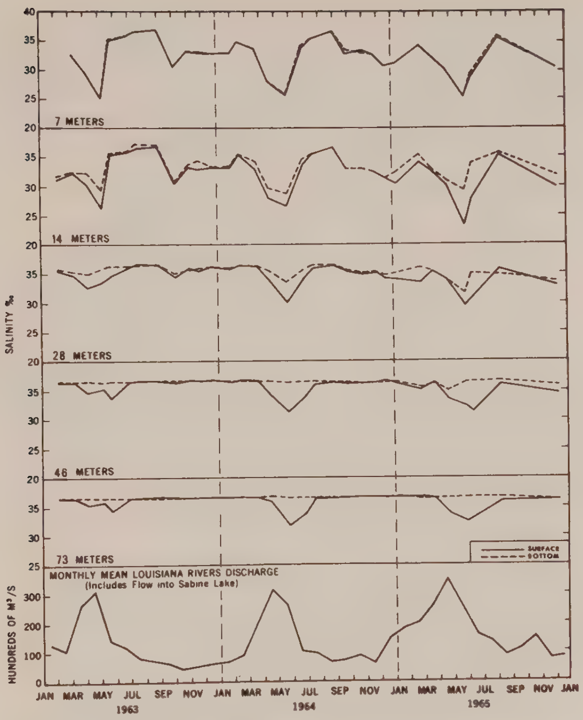


Figure 5.—Salinity trends in surface and bottom waters over the continental shelf off Texas, 1963-65.

peak outflow of fresh water from the Mississippi River although there may be a time lag of 1 to 2 mo. Superimposed on these marked changes were other minor changes evident at the shallower stations and which probably resulted from local river discharges.

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Table 1. Monthly temperature and salinity observations at stations on transect 1, 1963

TION: E-37
7 M
DE: 30°12' N
UDE: 88°00' W

ise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	26	2	1963	13.8	13.8						13.8	35.48	35.54					
4	26	4	1963	22.4	22.6						18.3	28.34	30.97					
6	19	6	1963	25.6	25.5						20.6	30.48	32.34					
8	21	8	1963	28.6	28.6						27.2	23.41	32.85					
	25	10	1963	24.1	24.3						24.4	30.76	33.34					
	14	12	1963	14.9	14.9						15.5	33.54	33.71					

TION: E-38
TH: 14 M
ITUDE: 30°09' N
UDE: 88°00' W

ise	Day	Month	Year	T 0	T 3	T 11	T 24	T 43	T 70	T 107	T B	S 0	S 3	S 11	S 24	S 43	S 70	S 107
	26	2	1963	12.9	12.9	12.9					12.9	35.22	00.00	35.13				
4	25	4	1963	23.0	22.4	17.9					17.8	30.46	31.07	35.14				
6	19	6	1963	25.1	24.9	21.7					21.7	32.69	32.73	35.91				
8	21	8	1963	00.0	00.0	00.0					00.0	27.35	33.33	35.30				
	25	10	1963	24.4	24.3	24.2					24.2	34.04	33.67	34.63				
	14	12	1963	15.2	15.2	15.4					15.9	34.09	34.12	34.45				

TION: E-39
TH: 28 M
ITUDE: 29°58' N
UDE: 88°00' W

ise	Day	Month	Year	T 0	T 3	T 11	T 24	T 43	T 70	T 107	T B	S 0	S 3	S 11	S 24	S 43	S 70	S 107
	28	2	1963	12.4	12.4	12.4	13.6				13.4	32.74	32.72	33.38	35.60			
4	25	4	1963	23.5	23.3	21.1	17.0				17.0	32.45	32.34	32.90	34.00			
6	19	6	1963	27.8	27.8	27.8	20.5				20.2	34.42	34.07	34.22	36.47			
8	21	8	1963	29.5	29.6	30.0	24.7				23.9	32.84	32.44	35.98	36.35			
	26	10	1963	25.2	25.2	25.2	25.2				24.8	35.70	35.80	35.68	35.69			
	14	12	1963	17.3	17.3	17.3	17.3				17.3	00.00	35.71	35.71	35.81			

TION: E-40
TH: 46 M
ITUDE: 29°30' N
UDE: 88°00' W

ise	Day	Month	Year	T 0	T 3	T 11	T 24	T 43	T 70	T 107	T B	S 0	S 3	S 11	S 24	S 43	S 70	S 107
2	28	2	1963	13.8	13.8	13.8	13.8	14.2			15.3	35.33	35.34	35.26	35.36	35.60		
4	25	4	1963	23.4	23.4	23.4	20.0	17.8			17.5	33.00	33.10	33.26	36.32	36.15		
6	18	6	1963	28.1	27.8	27.2	23.6	20.1			20.1	32.22	34.53	34.80	36.32	36.49		
	21	8	1963	30.2	30.2	30.2	27.8	21.9			21.9	33.51	33.34	35.51	36.42	36.46		
	26	10	1963	26.0	26.0	26.0	26.0	26.0			25.7	36.17	35.97	36.08	35.92	36.04		
	14	12	1963	20.8	20.8	20.8	20.7	20.7			20.7	36.39	36.30	36.36	36.36	36.32		

TION: E-41
TH: 73 M
DE: 29°25' N
UDE: 88°00' W

ise	Day	Month	Year	T 0	T 3	T 11	T 24	T 43	T 70	T 107	T B	S 0	S 3	S 11	S 24	S 43	S 70	S 107
	28	2	1963	15.2	15.2	15.2	15.0	14.6	15.3		15.3	35.79	00.00	00.00	00.00	00.00	00.00	
4	25	4	1963	23.1	23.2	23.3	21.1	20.3	18.2		17.7	34.66	34.38	34.86	35.53	36.35	36.25	
6	18	6	1963	28.2	27.9	27.7	24.9	20.8	18.6		17.9	32.05	34.18	36.41	36.60	36.54	00.00	
8	21	8	1963	30.1	29.9	30.0	28.9	23.9	19.9		19.9	33.76	33.69	34.75	36.39	36.35	36.42	
	26	10	1963	26.1	26.1	26.1	26.1	26.7	20.0		17.8	35.84	35.61	36.27	35.86	36.41	36.53	
	14	12	1963	20.4	20.4	20.4	20.4	20.4	17.6		17.6	36.01	36.02	36.05	00.00	00.00	36.77	

Table 2. Monthly temperature and salinity observations at stations on transect 2, 1963

STATION: E-36
DEPTH: 7 M
LATITUDE: 29°42' N
LONGITUDE: 88°52' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	26	2	1963	12.7	12.7						12.7	33.35	33.23				
4	24	4	1963	24.5	24.0						19.7	30.93	31.33				
6	18	6	1963	25.6	25.6						20.1	28.82	34.38				
8	21	8	1963	30.0	30.0						27.9	34.09	33.97				
10	24	10	1963	24.7	24.7						24.1	34.07	34.06				
12	13	12	1963	16.3	16.3						16.3	34.15	34.20				

STATION: E-35
DEPTH: 14 M
LATITUDE: 29°31' N
LONGITUDE: 88°52' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	25	2	1963	13.2	12.9	12.7					12.2	33.80	33.73	33.68			
4	24	4	1963	23.4	22.8	19.7					19.5	29.10	30.83	34.86			
6	18	6	1963	21.8	21.8	18.9					18.8	36.41	34.80	36.45			
8	20	8	1963	30.1	29.9	23.0					22.2	34.64	36.28	36.40			
10	24	10	1963	24.8	24.8	24.8					24.7	25.75	34.54	34.62			
12	13	12	1963	19.6	19.6	19.6					19.8	35.89	35.91	36.19			

STATION: E-34
DEPTH: 28 M
LATITUDE: 29°21' N
LONGITUDE: 88°52' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	25	2	1963	14.2	13.7	13.5	12.5				12.6	34.99	34.89	34.88	34.51		
4	24	4	1963	24.7	23.9	18.6	18.1				17.9	22.40	32.58	36.00	36.06		
6	18	6	1963	23.2	23.2	20.8	19.3				18.8	27.64	33.65	36.48	36.46		
8	20	8	1963	28.6	28.1	24.7	23.1				23.1	33.85	33.85	36.43	36.39		
10	24	10	1963	26.1	26.1	26.1	26.4				26.6	35.45	35.44	35.51	35.82		
12	13	12	1963	20.5	20.4	20.3	20.0				20.0	35.87	35.87	35.89	35.98		

STATION: E-33
DEPTH: 46 M
LATITUDE: 29°18' N
LONGITUDE: 88°52' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	25	2	1963	13.6	14.3	14.5	15.2	14.3			14.2	33.90	34.36	34.98	35.40	35.18	
4	24	4	1963	24.3	21.4	19.1	18.6	17.3			17.3	23.02	00.00	36.32	36.24	36.10	
6	18	6	1963	22.7	22.2	20.7	19.2	18.2			18.2	00.00	36.34	36.50	36.48	36.37	
8	20	8	1963	28.0	26.9	23.3	22.2	22.1			22.1	33.05	33.67	36.44	36.39	36.42	
10	23	10	1963	25.7	25.7	25.8	26.8	26.9			26.9	35.19	35.08	35.23	35.95	36.68	
12	13	12	1963	19.9	20.0	20.4	20.4	20.1			20.1	34.14	34.35	34.31	35.95	36.34	

STATION: E-32
DEPTH: 73 M
LATITUDE: 29°09' N
LONGITUDE: 88°52' W

Cruise	Day	Month	Year	Temperature (°C) Depth (M)								Salinity (o/oo) Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	25	2	1963	13.9	14.8	14.8	15.3	16.1	14.7		14.6	33.48	35.03	35.45	35.66	35.93	36.0
4	24	4	1963	20.9	21.7	22.1	20.9	19.2	17.6		17.6	20.55	35.29	36.22	36.56	36.28	36.2
6	18	6	1963	27.1	27.1	23.6	20.8	18.6	17.1		16.4	33.51	35.98	36.48	36.56	36.22	36.4
8	20	8	1963	29.6	29.6	26.7	20.8	19.4	17.3		17.2	24.80	32.30	35.46	36.36	36.49	36.3
10	23	10	1963	26.2	26.2	26.5	26.8	27.1	22.2		19.3	35.04	35.12	35.55	35.81	36.64	36.6
12	13	12	1963	19.8	19.9	20.0	20.6	20.1	17.8		17.7	33.98	34.21	34.65	35.80	36.42	36.2

Table 3. Monthly temperature and salinity observations at stations on transect 3, 1963-1965

ATION: E-44
: 7 M
UDE: 29°15' N
TUDE: 89°42' W

uise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	24	2	1963	14.3	14.3						14.3	32.40	32.32					
3	29	3	1963	19.9	19.9						17.9	21.15	21.50					
4	27	4	1963	27.1	26.8						25.8	19.91	19.77					
5	17	5	1963	28.1	28.1						25.2	28.61	29.04					
	22	6	1963	27.3	27.3						27.3	25.78	25.94					
	12	7	1963	28.9	28.9						28.4	31.53	32.02					
	19	8	1963	29.9	29.4						27.7	27.71	33.08					
	26	9	1963	27.1	27.0						26.8	31.10	31.13					
10	23	10	1963	25.1	25.1						26.3	32.51	32.48					
11	23	11	1963	21.8	21.8						22.1	32.29	32.13					
	12	12	1963	16.0	16.0						17.2	33.31	33.19					
	22	1	1964	13.8	13.7						13.4	32.93	33.09					
	10	2	1964	15.6	15.6						15.6	34.44	34.40					
	29	2	1964	14.7	14.8						15.6	32.41	31.88					
	24	4	1964	27.3	27.2						19.5	15.64	17.83					
	17	5	1964	25.1	25.0						24.9	13.26	13.22					
	20	6	1964	30.9	30.5						22.8	14.60	14.71					
	12	7	1964	29.1	29.1						26.6	26.55	33.16					
	24	8	1964	31.7	30.3						29.7	24.75	28.29					
	20	9	1964	28.4	28.3						28.2	30.39	30.55					
	24	10	1964	22.2	22.3						22.3	32.89	32.92					
23	13	11	1964	21.9	21.9						21.7	29.79	29.80					
24	11	12	1964	17.6	17.6						16.3	32.28	32.26					
	18	1	1965	15.4	15.5						21.0	31.55	31.61					
	12	2	1965	18.7	18.7						18.6	30.28	30.51					
	15	3	1965	17.7	17.6						17.3	27.17	27.57					
	17	4	1965	23.5	23.5						20.1	20.55	20.47					
29	22	5	1965	25.2	25.3						23.6	13.44	16.18					
30	21	6	1965	28.4	28.4						27.9	23.34	23.37					
32	22	8	1965	28.4	28.3						28.7	00.00	00.00					
	29	10	1965	22.5	22.5						25.6	31.96	31.94					
	4	12	1965	19.9	20.0						20.4	33.49	33.42					

ON: E-25
PTH: 14 M
TITUDE: 29°10' N
TUDE: 89°42' W

uise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	26	1	1963	15.3	15.3	15.3					15.3	34.05	34.00	33.98				
	24	2	1963	14.6	14.6	14.6					14.6	32.39	32.62	32.68				
3	29	3	1963	19.9	19.4	17.8					17.8	21.08	21.01	33.12				
4	27	4	1963	25.4	25.4	19.2					19.1	19.84	19.84	34.55				
5	17	5	1963	26.9	26.9	25.6					22.6	30.32	30.44	32.02				
	21	6	1963	28.4	28.3	27.7					26.1	28.99	35.41	33.91				
	12	7	1963	29.2	29.2	28.3					26.7	31.01	32.99	35.40				
	19	8	1963	30.0	30.3	30.7					28.2	32.79	32.76	34.14				
	26	9	1963	27.8	27.8	27.8					27.8	32.54	32.37	32.58				
10	23	10	1963	24.9	24.9	26.1					27.1	32.02	32.24	35.61				
11	23	11	1963	22.3	22.3	22.3					22.4	34.12	34.11	34.16				
	12	12	1963	18.7	18.7	18.7					18.6	35.48	35.33	35.31				
	22	1	1964	14.7	14.5	14.6					14.6	33.73	33.79	35.11				
	10	2	1964	16.4	16.4	16.4					16.4	34.81	34.89	34.87				
	28	2	1964	15.5	15.5	15.5					15.5	32.86	32.84	34.87				
16	24	4	1964	22.3	22.3	19.9					19.9	17.88	18.01	30.20				
17	17	5	1964	24.2	24.3	24.4					23.6	15.47	15.60	21.50				
18	20	6	1964	30.1	30.1	24.0					22.1	20.51	24.71	21.36				
	12	7	1964	29.2	29.2	27.7					27.0	31.19	31.14	36.24				
	24	8	1964	31.7	30.0	29.2					28.4	29.07	31.65	32.87				
	20	9	1964	28.1	27.9	28.3					28.2	30.12	30.10	31.64				
	24	10	1964	22.3	22.3	23.0					23.1	33.24	33.13	33.77				
23	13	11	1964	21.8	22.2	22.5					24.5	29.62	29.81	34.79				
24	11	12	1964	18.1	18.1	17.7					17.8	32.89	32.82	33.52				
	18	1	1965	16.9	16.8	20.5					21.3	32.50	32.49	32.62				
	12	2	1965	18.6	18.6	18.5					16.6	31.23	31.25	32.49				
	15	3	1965	16.7	16.7	16.5					17.7	26.99	28.08	32.52				
	17	4	1965	22.7	22.3	19.7					19.7	19.43	19.53	34.82				
29	22	5	1965	25.3	25.3	23.0					22.8	19.00	19.02	35.21				
30	21	6	1965	28.0	28.0	28.0					26.7	24.13	24.02	24.64				
32	22	8	1965	28.5	28.5	28.6					28.6	30.35	30.67	34.31				
	29	10	1965	22.6	22.6	25.7					25.8	32.01	32.03	33.24				
	4	12	1965	20.7	20.8	21.2					21.2	33.40	33.46	33.82				

Table 3. (Continued)

STATION: E-26
DEPTH: 28 M
LATITUDE: 29°05' N
LONGITUDE: 89°42' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	26	1	1963	15.4	15.4	15.4	16.5				16.5	33.22	33.20	33.17	34.44		
2	24	2	1963	14.7	14.6	14.8	14.2				16.3	31.97	32.11	32.86	33.52		
3	29	3	1963	18.8	18.8	18.6	18.3				18.3	20.40	20.64	30.02	35.37		
4	27	4	1963	25.8	25.8	22.2	20.1				20.1	21.50	21.43	27.30	36.11		
5	17	5	1963	27.4	27.4	24.1	21.7				20.7	32.00	31.99	35.83	36.50		
6	21	6	1963	28.1	27.9	27.4	20.2				20.3	32.64	32.66	33.41	36.40		
7	12	7	1963	29.9	29.9	28.9	21.9				20.4	29.89	30.34	34.90	39.26		
8	20	8	1963	30.2	30.1	30.0	23.3				23.3	33.74	33.77	34.09	34.84		
9	26	9	1963	28.1	27.9	27.9	28.1				28.1	33.21	33.16	33.14	33.20		
10	23	10	1963	25.1	25.1	25.9	27.2				27.2	31.52	31.45	32.89	36.60		
11	23	11	1963	23.6	23.6	23.8	23.6				24.1	35.48	35.63	35.92	36.28		
12	12	12	1963	20.8	20.8	20.8	20.8				16.3	36.16	36.16	36.15	36.26		
13	22	1	1964	15.9	15.9	15.9	16.0				16.1	34.86	34.69	34.81	35.59		
14	10	2	1964	17.2	17.2	17.2	17.3				18.7	34.98	35.04	35.00	35.13		
15	28	2	1964	15.8	15.8	15.9	16.2				17.1	32.88	32.76	33.89	35.47		
16	24	4	1964	22.3	22.2	22.4	19.8				18.6	24.78	27.48	33.93	35.82		
17	17	5	1964	23.7	23.7	23.9	22.9				21.3	15.77	16.56	24.17	31.58		
18	20	6	1964	29.7	29.5	26.5	22.1				21.4	19.53	19.77	35.73	36.58		
19	12	7	1964	29.8	29.8	28.8	26.5				25.3	26.93	27.00	34.34	36.73		
20	24	8	1964	30.8	29.8	29.5	24.7				22.6	27.70	28.01	30.18	36.49		
21	20	9	1964	28.1	28.1	28.2	27.0				27.0	33.56	33.40	34.23	36.32		
22	23	10	1964	22.6	22.6	22.7	24.2				24.6	33.26	33.27	33.63	34.78		
23	13	11	1964	22.2	22.4	23.3	24.6				24.6	29.66	29.74	33.04	36.42		
24	11	12	1964	19.1	19.1	19.1	18.4				18.3	32.78	32.83	32.78	33.65		
25	17	1	1965	17.5	17.5	18.9	21.2				21.2	33.03	32.99	34.49	36.40		
26	12	2	1965	18.7	18.3	18.3	20.0				20.6	29.28	30.13	32.45	35.77		
27	15	3	1965	16.7	16.7	16.5	17.9				17.9	20.62	25.98	31.88	35.28		
28	17	4	1965	24.3	24.2	22.3	20.2				20.0	14.26	17.56	36.02	36.70		
29	22	5	1965	25.3	25.3	24.8	24.5				23.5	18.35	18.38	36.19	36.70		
30	21	6	1965	28.0	28.0	28.0	25.9				25.9	22.35	22.80	27.67	35.42		
32	22	8	1965	28.7	28.6	29.2	27.1				25.5	28.20	28.18	32.79	36.65		
34	29	10	1965	23.1	23.2	24.7	26.2				26.2	32.16	32.12	33.51	35.23		
35	4	12	1965	21.3	21.7	22.6	24.0				24.0	33.30	32.79	33.93	35.25		

STATION: E-27
DEPTH: 46 M
LATITUDE: 28°59' N
LONGITUDE: 89°42' W

1	26	1	1963	16.0	16.0	16.2	16.9	18.6			18.7	33.33	33.41	33.80	34.42	35.68	
2	25	2	1963	14.7	14.8	15.2	15.6	16.9			17.1	31.74	31.92	33.38	34.16	35.62	
3	29	3	1963	17.7	19.9	19.6	19.8	19.8			19.9	16.38	20.27	28.64	36.16	36.24	
4	27	4	1963	24.7	24.4	21.3	20.5	18.9			18.9	21.94	23.54	31.79	36.30	36.26	
5	17	5	1963	27.4	27.2	24.1	22.0	19.1			19.0	30.80	30.84	36.07	36.57	36.34	
6	21	6	1963	28.0	27.8	27.6	20.9	18.9			18.3	32.42	32.51	32.90	36.41	36.36	
7	12	7	1963	29.8	29.8	29.7	24.2	19.3			18.6	31.65	31.66	32.68	36.52	36.36	
8	20	8	1963	30.1	30.0	30.0	24.4	20.2			20.1	33.88	33.80	33.85	36.48	36.35	
9	26	9	1963	27.8	27.5	27.8	28.0	28.0			28.0	33.35	33.25	33.41	34.08	34.41	
10	23	10	1963	25.1	25.1	26.1	26.7	26.4			26.0	31.77	31.65	34.57	36.04	36.65	
11	23	11	1963	23.2	23.2	23.2	23.3	23.4			23.4	35.51	35.58	35.52	35.96	36.17	
12	12	12	1963	21.6	21.6	21.4	21.4	20.7			20.3	36.40	36.47	36.51	36.50	36.43	
13	22	1	1964	19.1	19.1	19.1	19.0	17.2			16.9	36.53	36.50	36.52	36.46	36.18	
14	10	2	1964	17.2	17.2	17.3	18.1	18.8			18.8	34.89	34.84	34.87	35.43	36.24	
15	28	2	1964	16.6	16.6	16.8	17.2	17.8			17.8	33.14	33.05	33.78	35.87	36.50	
16	24	4	1964	22.1	22.2	22.9	22.3	19.3			18.9	30.79	32.97	36.65	36.81	36.78	
17	17	5	1964	23.7	23.8	23.8	24.4	23.2			21.8	17.92	17.80	28.79	35.99	36.33	
18	20	6	1964	30.3	30.3	27.2	25.4	18.6			18.4	18.59	19.01	35.41	31.40	36.31	
19	12	7	1964	29.5	29.6	28.8	27.8	21.8			19.2	28.99	33.37	36.32	36.64	36.66	
20	24	8	1964	29.8	29.7	29.5	27.7	20.7			20.3	29.79	29.64	32.24	36.50	36.53	
21	20	9	1964	28.5	28.5	28.7	28.2	22.2			21.4	29.79	29.78	31.46	35.78	36.50	
22	23	10	1964	22.7	22.7	22.8	25.1	25.1			24.9	33.31	33.26	33.60	36.47	36.47	
23	13	11	1964	24.1	24.1	24.2	24.2	24.2			24.3	36.15	36.22	36.41	36.31	36.36	
24	11	12	1964	19.7	19.7	18.8	21.7	22.1			22.1	33.65	33.78	33.87	35.65	36.15	
25	17	1	1965	19.2	19.2	19.2	19.6	21.1			21.1	34.52	34.36	34.59	34.86	36.52	
26	11	2	1965	18.7	18.3	17.6	19.5	20.2			20.2	28.55	29.68	33.19	35.52	36.46	
27	15	3	1965	15.7	15.8	16.8	17.0	18.7			17.5	18.18	24.96	32.88	34.71	36.00	
28	17	4	1965	23.5	22.7	23.1	21.0	19.5			19.5	13.72	19.02	35.92	36.59	36.56	
29	22	5	1965	24.7	24.7	24.5	24.0	21.3			21.3	36.27	36.62	36.37	36.49	36.50	
30	21	6	1965	27.8	27.7	27.5	27.0	23.3			22.1	20.92	21.15	30.44	36.28	36.47	
32	21	8	1965	29.0	29.2	29.4	27.7	22.2			22.2	27.79	27.79	31.99	36.28	36.61	
34	29	10	1965	22.9	23.0	25.0	25.2	26.5			26.5	31.78	31.78	33.24	35.39	36.13	
35	4	12	1965	23.7	23.7	23.7	23.6	23.6			23.6	36.47	00.00	00.00	36.49	36.51	

Table 3. (Continued)

ATION: E-43
: 73 M
UDE: 28°48' N
TUDE: 89°42' W

uise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	26	1	1963	17.5	17.5	17.6	17.8	18.4	18.5		18.4	34.93	34.97	35.11	35.60	36.03	36.16	
2	25	2	1963	16.4	16.5	16.6	16.8	17.2	16.9		16.8	28.95	34.90	35.32	34.98	36.05	36.28	
3	29	3	1963	19.5	19.7	19.3	19.7	18.7	17.1		17.2	14.99	29.17	35.18	36.40	36.35	36.08	
4	27	4	1963	25.6	24.2	22.7	22.1	20.7	17.9		17.9	24.15	30.40	35.94	36.48	36.41	36.25	
	16	5	1963	27.3	25.8	24.2	22.2	19.4	17.2		17.2	29.23	30.92	35.57	36.19	36.28	36.38	
	21	6	1963	28.4	28.3	28.2	25.0	20.7	17.4		17.4	31.52	31.52	32.33	36.43	36.55	36.40	
	13	7	1963	29.4	29.6	29.3	25.6	19.4	17.3		17.3	33.49	33.04	35.07	36.32	34.74	36.42	
8	20	8	1963	29.6	29.7	30.2	25.6	20.8	16.6		16.6	33.48	33.34	33.75	36.48	36.41	36.17	
9	26	9	1963	27.9	27.9	28.1	28.2	28.3	28.4		28.3	35.50	35.40	35.78	35.93	36.00	36.18	
10	23	10	1963	26.7	26.8	26.9	27.1	27.2	21.1		18.2	36.18	36.10	36.32	36.57	36.64	36.43	
	23	11	1963	23.9	23.9	23.9	23.9	23.8	22.9		21.9	36.67	36.62	36.70	36.68	36.76	36.67	
	13	12	1963	22.4	22.4	22.4	22.1	21.7	19.6		18.1	36.95	36.62	36.57	00.00	36.59	36.39	
	22	1	1964	19.2	19.2	19.1	18.8	18.2	17.0		16.9	36.63	36.60	36.62	36.63	36.50	36.37	
	10	2	1964	17.2	17.2	17.7	17.8	17.8	17.8		16.0	34.87	34.93	35.97	36.47	36.38	36.59	
15	28	2	1964	15.2	15.4	17.3	18.8	18.8	18.3		17.8	32.08	32.17	33.57	36.25	36.41	36.36	
16	24	4	1964	21.3	21.2	22.0	22.5	22.0	18.4		18.3	29.69	33.06	35.58	36.52	36.78	36.51	
17	17	5	1964	24.6	24.6	23.9	23.9	22.9	18.4		17.6	24.55	24.19	32.80	36.39	36.57	36.50	
	20	6	1964	30.7	30.7	30.5	28.2	24.4	19.8		19.8	18.67	28.90	36.55	36.80	36.72	36.48	
	12	7	1964	29.9	29.4	28.6	27.7	22.4	13.8		13.8	27.94	34.24	36.38	36.62	36.82	35.88	
	24	8	1964	29.7	29.6	28.1	25.4	24.4	18.9		18.9	29.81	29.80	36.37	36.22	36.49	36.42	
21	20	9	1964	28.8	28.8	28.9	28.8	22.3	19.1		19.1	33.52	33.58	35.17	35.82	36.60	36.93	
22	23	10	1964	24.8	24.8	24.8	24.7	24.6	17.4		17.3	36.52	36.49	36.49	36.52	36.50	36.58	
23	13	11	1964	24.3	24.4	24.5	24.4	24.4	19.5		19.4	36.23	36.24	36.57	36.56	36.60	36.51	
	11	12	1964	22.3	22.3	22.3	22.3	22.2	21.9		19.5	36.56	36.58	36.64	36.60	36.58	36.59	
	11	2	1965	21.8	21.8	21.8	21.7	21.7	20.8		20.6	36.72	36.87	36.71	36.76	36.55	36.69	
	17	4	1965	22.5	22.7	23.0	22.4	19.6	16.6		16.7	24.88	23.11	35.18	36.48	36.33	36.64	
	23	5	1965	25.1	25.1	25.1	24.4	22.8	19.5		19.4	36.67	36.73	36.70	36.66	36.61	36.54	
30	21	6	1965	24.9	24.9	24.2	22.9	20.2	20.0		20.0	30.46	31.99	33.74	35.53	36.68	36.55	
32	21	8	1965	27.1	27.1	26.4	22.5	20.3	19.4		19.4	28.20	28.19	32.72	35.34	36.64	36.73	
	20	9	1965	27.4	27.4	27.4	27.6	27.2	25.5		24.0	30.99	33.58	35.41	36.00	00.00	35.97	
	28	10	1965	24.8	25.0	27.0	26.5	26.5	22.5		22.5	31.78	31.78	36.22	36.22	36.28	36.49	

Table 4. Monthly temperature and salinity observations at stations on transect 4, 1963-1965

N: E-45
7 M
TITUDE: 29°00' N
NGITUDE: 90°40' W

	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
2	23	2	1963	13.2	13.2						13.3	34.26	34.12					
	30	3	1963	20.4	20.4						20.3	25.85	25.82					
	28	4	1963	26.2	26.2						24.9	25.52	25.55					
	17	5	1963	27.2	25.0						23.5	21.97	32.13					
	22	6	1963	26.8	26.8						26.8	28.97	29.05					
7	12	7	1963	29.6	30.2						28.8	25.16	29.26					
8	19	8	1963	29.4	29.2						28.8	32.37	32.66					
9	27	9	1963	27.7	27.7						27.1	35.63	35.59					
	22	10	1963	25.1	25.0						24.9	32.60	32.38					
	22	11	1963	20.8	20.8						20.7	34.21	34.10					
	12	12	1963	17.2	17.2						17.2	35.06	35.20					
	23	1	1964	14.7	14.2						14.6	34.90	34.92					
14	9	2	1964	13.0	14.2						14.8	32.04	32.44					
15	29	2	1964	14.8	14.8						14.7	33.77	33.77					
	25	4	1964	23.8	23.7						21.2	18.21	18.21					
	17	5	1964	24.9	24.8						24.8	16.70	16.81					
	20	6	1964	31.3	30.0						24.8	00.00	21.38					
	12	7	1964	29.4	29.3						26.4	27.39	28.18					
20	25	8	1964	30.2	30.5						28.2	26.33	26.94					
21	21	9	1964	28.7	28.7						28.7	31.03	31.00					
22	24	10	1964	21.3	21.3						21.3	34.09	33.48					
	13	11	1964	22.6	22.5						22.0	30.60	30.47					
	10	12	1964	16.8	16.6						15.8	32.73	32.71					
	17	1	1965	15.5	15.6						15.7	30.18	30.12					
	12	2	1965	18.8	18.8						18.8	31.45	31.33					
27	16	3	1965	17.8	17.7						16.6	28.42	28.31					
28	18	4	1965	22.7	22.8						22.8	25.78	25.70					
	22	5	1965	25.4	25.4						24.9	19.61	20.81					
	22	6	1965	27.8	27.8						27.8	25.46	25.37					
	22	7	1965	28.5	28.6						29.1	30.74	30.76					
	19	9	1965	28.2	28.2						28.2	31.22	31.18					
34	29	10	1965	20.6	20.5						20.3	31.13	30.86					
35	3	12	1965	19.0	19.2						19.4	31.74	31.85					

Táble 4. (Continued)

STATION: E-24
DEPTH: 14 M
LATITUDE: 28°53' N
LONGITUDE: 90°40' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	25	1	1963	15.3	15.3	15.3					15.3	34.10	34.01	33.98			
2	22	2	1963	14.3	14.3	14.3					14.3	34.67	34.70	34.60			
3	30	3	1963	20.2	20.2	20.2					19.9	30.16	30.24	30.20			
4	28	4	1963	25.7	25.7	21.1					20.7	27.02	27.01	29.10			
5	17	5	1963	27.0	26.9	21.7					21.5	28.01	27.93	35.50			
6	22	6	1963	27.4	27.4	27.4					26.5	31.80	31.94	00.00			
7	12	7	1963	29.9	29.9	27.2					26.9	27.05	36.83	34.84			
8	19	8	1963	29.8	29.9	30.0					28.8	32.98	32.90	35.00			
9	27	9	1963	28.0	28.0	28.0					28.0	35.78	35.65	35.62			
10	22	10	1963	25.7	25.7	25.8					25.5	33.77	33.75	33.87			
11	22	11	1963	21.3	21.3	21.4					21.6	34.97	35.04	35.08			
12	12	12	1963	19.2	19.2	19.1					19.0	35.85	35.80	36.15			
13	23	1	1964	15.2	14.7	14.7					14.8	35.16	35.11	35.29			
14	9	2	1964	15.7	15.7	15.7					15.6	35.38	35.30	35.32			
15	29	2	1964	14.9	14.9	14.8					14.8	33.96	33.91	33.95			
16	25	4	1964	24.0	24.1	20.7					20.7	17.55	17.61	30.81			
17	17	5	1964	24.9	24.9	24.1					23.3	18.67	18.71	30.61			
18	20	6	1964	30.2	30.0	24.7					24.2	20.62	20.88	34.45			
19	12	7	1964	29.3	29.2	26.6					26.5	28.56	28.75	36.18			
20	25	8	1964	30.2	30.2	27.9					27.9	28.13	28.10	35.95			
21	20	9	1964	28.6	28.6	28.5					28.5	31.80	31.80	31.88			
22	24	10	1964	22.8	22.8	22.8					22.8	33.89	33.81	33.93			
23	13	11	1964	22.7	22.6	23.0					23.7	30.36	30.31	00.00			
24	10	12	1964	18.3	18.3	17.8					17.8	33.28	33.26	33.39			
25	18	1	1965	15.4	15.4	18.2					18.5	00.00	32.31	34.30			
26	12	2	1965	19.1	19.1	19.1					19.1	34.48	34.42	34.55			
27	16	3	1965	17.5	17.5	16.3					16.3	30.87	30.86	32.68			
28	18	4	1965	23.0	23.0	20.2					20.2	27.35	27.48	30.86			
29	22	5	1965	25.0	25.0	25.2					24.0	26.44	27.03	32.43			
30	22	6	1965	27.8	27.8	27.9					26.8	25.68	25.68	30.15			
32	22	8	1965	28.3	28.7	28.7					28.2	31.29	30.88	33.88			
33	19	9	1965	28.3	28.3	28.3					28.0	31.98	32.30	32.01			
34	29	10	1965	22.6	22.6	23.0					23.9	32.14	32.18	32.27			
35	3	12	1965	20.8	20.8	20.8					20.9	33.62	33.44	33.48			

STATION: E-23
DEPTH: 28 M
LATITUDE: 28°33' N
LONGITUDE: 90°40' W

1	27	1	1963	17.1	17.1	17.0	17.1				17.2	34.86	35.03	35.34	35.51		
2	23	2	1963	16.4	16.4	16.4	16.4				16.8	36.08	36.12	36.15	36.18		
3	29	3	1963	19.7	19.7	19.3	18.9				18.9	35.53	35.44	35.43	35.88		
4	23	4	1963	23.2	22.8	22.4	19.9				19.9	35.85	35.69	36.39	36.42		
5	16	5	1963	26.7	26.4	25.0	21.9				21.2	31.47	31.50	34.92	36.02		
6	21	6	1963	28.4	28.4	28.1	21.9				21.9	33.17	33.18	33.60	36.21		
7	13	7	1963	29.6	29.6	29.7	22.4				21.9	31.85	31.76	33.77	36.39		
8	19	8	1963	29.9	30.0	30.1	23.9				23.9	33.94	00.00	34.35	36.27		
9	26	9	1963	28.2	28.2	28.1	28.0				28.0	36.15	36.24	36.31	36.48		
10	22	10	1963	26.2	26.2	26.3	26.5				26.6	34.44	36.72	36.18	36.35		
11	22	11	1963	23.1	23.1	23.1	23.0				23.0	36.01	36.97	35.99	35.94		
12	15	12	1963	18.2	18.2	18.2	18.2				18.0	35.99	36.10	36.10	36.64		
13	20	1	1964	17.8	17.8	17.8	17.8				17.8	36.31	36.45	36.59	36.60		
14	9	2	1964	17.1	17.1	17.1	16.9				16.8	36.57	36.63	36.57	36.62		
15	1	3	1964	17.1	17.1	17.1	17.1				17.1	36.39	36.33	36.31	36.40		
16	23	4	1964	22.5	22.3	22.2	20.6				20.7	35.92	35.95	36.42	36.26		
17	14	5	1964	25.1	25.1	24.8	24.6				21.9	33.05	33.22	36.16	36.67		
18	19	6	1964	28.0	28.0	27.4	23.9				22.8	36.24	36.23	36.70	36.69		
19	11	7	1964	29.4	29.4	28.0	25.7				25.4	29.67	31.32	36.32	36.63		
20	23	8	1964	30.8	30.2	29.8	26.8				25.9	32.54	32.51	32.61	36.39		
21	19	9	1964	29.2	29.2	29.2	27.2				24.2	34.54	34.59	35.46	36.42		
22	23	10	1964	23.8	23.8	23.8	24.1				24.2	35.20	35.11	35.49	36.09		
23	12	11	1964	23.3	23.6	23.7	24.1				24.1	34.45	35.21	35.35	36.21		
24	12	12	1964	21.3	21.3	21.3	21.3				21.3	36.34	36.29	36.36	36.34		
25	19	1	1965	20.3	20.3	20.2	20.0				18.1	36.77	36.76	36.75	36.67		
27	14	3	1965	17.0	16.7	16.8	18.1				18.1	31.19	31.89	34.02	35.90		
28	17	4	1965	22.5	22.4	22.3	20.3				19.5	35.40	35.27	35.64	36.35		
29	23	5	1965	24.8	24.8	24.7	24.7				23.8	36.79	36.90	36.49	36.53		
30	20	6	1965	29.1	29.0	28.3	26.0				25.0	33.53	33.53	35.05	36.45		
32	20	8	1965	28.9	28.8	29.2	27.2				27.2	33.32	33.37	33.72	36.42		
33	19	9	1965	28.6	28.6	27.7	27.3				27.0	33.03	33.03	34.31	34.99		
34	29	10	1965	25.2	25.2	25.2	25.3				25.4	35.70	35.68	35.63	35.69		

Table 4. (Continued)

ON: E-22
: 46 M
: 28°22' N
E: 90°40' W

e	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				Depth (M)								Depth (M)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	28	1	1963	19.2	19.2	19.2	19.2	19.3			19.2	36.29	36.32	36.40	36.33	36.33		
	23	2	1963	16.9	16.9	16.9	16.9	16.9			17.0	36.38	36.33	36.60	36.33	36.43		
	28	3	1963	20.4	20.4	20.3	20.1	19.4			19.4	36.43	36.32	36.16	36.39	36.43		
	22	4	1963	23.2	22.8	22.6	21.9	19.3			19.4	36.53	36.59	36.60	36.58	36.56		
	16	5	1963	25.8	25.6	25.4	24.6	20.2			20.2	36.79	36.62	36.67	36.65	36.53		
	21	6	1963	28.7	28.7	28.3	23.9	20.9			20.9	33.85	33.72	34.34	36.28	36.46		
	13	7	1963	29.7	29.8	29.8	26.7	21.1			20.4	32.47	32.36	32.87	34.93	34.45		
	19	8	1963	29.9	29.9	30.0	27.2	22.1			22.0	33.98	33.88	34.92	35.23	36.40		
	26	9	1963	28.3	28.3	28.3	28.2	28.2			28.2	36.46	36.55	36.45	36.44	36.40		
	22	10	1963	26.9	26.9	26.9	26.9	26.9			26.6	36.66	36.68	36.61	36.69	36.67		
	22	11	1963	23.7	23.7	23.7	23.6	23.6			23.6	36.71	36.67	36.75	36.68	36.69		
	15	12	1963	20.4	20.4	20.4	20.4	20.4			20.4	36.53	36.54	36.47	36.50	36.57		
	20	1	1964	19.2	19.2	19.2	18.5	18.4			18.4	36.47	36.50	36.48	36.59	36.52		
	9	2	1964	18.2	18.2	18.1	18.1	18.0			18.0	36.75	36.64	36.56	36.61	36.58		
	1	3	1964	17.5	17.5	17.5	17.5	17.5			17.5	36.58	36.61	36.59	36.57	00.00		
	24	4	1964	23.4	23.2	22.7	21.8	19.7			19.2	36.92	36.89	36.88	36.68	36.63		
	14	5	1964	25.3	25.3	25.1	24.3	20.8			20.5	36.81	36.76	36.95	36.73	36.52		
	19	6	1964	27.6	27.6	27.6	26.9	22.8			20.7	36.88	36.90	36.88	36.90	36.74		
	11	7	1964	29.2	29.1	28.4	27.8	22.6			20.7	30.60	30.70	36.14	36.65	36.73		
	23	8	1964	30.6	30.4	29.8	26.7	21.4			21.4	31.78	31.58	31.66	36.60	36.55		
	19	9	1964	29.5	29.4	29.3	29.3	25.7			22.7	35.92	35.92	35.89	36.05	36.50		
	23	10	1964	24.6	24.6	24.6	24.6	24.7			24.7	36.26	36.31	36.29	36.44	36.37		
	12	11	1964	23.9	23.9	23.8	23.8	24.1			24.1	32.80	35.99	35.97	36.10	36.48		
	12	12	1964	21.5	21.6	21.6	21.6	21.5			21.5	36.44	36.42	36.47	36.55	36.49		
	19	1	1965	20.3	20.3	20.3	20.2	20.2			20.2	36.63	36.60	36.62	36.63	36.58		
	15	3	1965	17.4	17.4	17.6	18.9	18.8			18.7	32.94	33.08	34.48	36.32	36.42		
	17	4	1965	23.0	23.0	22.9	22.5	22.5			19.0	36.33	36.37	36.38	36.39	36.35		
	23	5	1965	24.7	24.7	24.7	24.5	21.2			20.3	36.64	36.59	36.60	36.60	36.48		
	21	6	1965	28.2	28.2	28.1	27.0	24.0			23.1	36.20	36.35	36.47	36.56	36.54		
	20	8	1965	29.0	29.0	29.0	28.7	23.2			22.7	34.29	34.36	34.43	36.10	36.58		
	18	9	1965	28.5	28.5	28.0	27.7	26.5			26.5	32.70	32.72	33.51	34.43	35.86		
	30	10	1965	25.5	25.5	25.5	25.5	25.6			25.6	36.09	36.03	36.08	36.16	36.29		

E-46
: 73 M
UDE: 28°14' N
TUDE: 90°40' W

e	Day	Month	Year	Temperature (°C)								Salinity (o/oo)						
				0	3	11	24	43	70	107	B	0	3	11	24	43	70	107
	28	1	1963	19.3	19.2	19.2	19.1	19.0	18.8		18.7	36.39	36.48	36.48	36.41	36.47	36.43	
	23	2	1963	18.3	18.2	18.2	18.1	18.1	18.0		17.9	36.53	36.42	36.52	36.61	36.53	36.51	
	28	3	1963	21.4	21.1	20.9	20.8	19.7	18.9		18.9	36.70	36.59	36.57	36.61	36.54	36.42	
	23	4	1963	23.7	23.3	22.7	22.1	20.6	18.6		18.6	36.65	36.58	36.62	36.62	36.42	00.00	
	16	5	1963	25.7	25.6	25.1	24.6	22.3	18.3		18.3	36.65	36.65	36.62	36.61	36.57	36.41	
	21	6	1963	28.4	28.4	28.3	27.2	23.3	18.7		18.8	35.75	35.84	35.85	36.42	36.54	36.37	
	13	7	1963	29.4	29.4	29.7	26.1	21.9	18.9		17.7	33.78	33.63	34.19	35.58	36.51	36.47	
	19	8	1963	29.9	29.9	30.0	30.0	25.6	19.8		19.7	34.34	34.31	34.91	36.15	36.30	36.42	
	26	9	1963	27.7	27.7	27.6	27.6	27.5	24.4		23.1	36.55	36.54	36.52	36.50	36.51	36.56	
	22	10	1963	27.1	27.0	26.9	26.8	26.8	24.7		19.9	36.60	36.58	36.60	36.62	36.74	36.56	
	23	11	1963	24.0	24.0	23.9	23.9	23.9	23.1		20.7	36.78	36.78	36.83	36.74	36.76	36.67	
	15	12	1963	21.9	21.9	21.9	21.9	21.9	20.9		20.7	36.64	36.67	36.63	36.64	36.60	36.45	
	20	1	1964	16.4	16.3	16.2	16.2	16.4	15.7		15.6	36.63	36.61	36.62	36.59	36.62	36.62	
	9	2	1964	19.0	19.0	19.0	19.0	19.0	18.1		17.9	36.82	36.62	36.77	36.66	36.58	36.66	
	1	3	1964	18.0	18.0	18.0	18.0	17.9	17.6		17.6	36.58	36.54	36.55	36.57	36.62	36.56	
	24	4	1964	23.8	23.8	22.7	21.6	20.0	18.2		18.2	36.89	36.94	36.95	36.70	36.75	36.68	
	14	5	1964	25.4	25.3	25.2	23.3	20.7	19.2		18.6	36.88	36.79	36.81	36.68	36.62	36.51	
	19	6	1964	28.3	28.2	28.1	26.7	23.8	19.5		18.1	36.95	36.91	36.79	36.87	36.76	36.49	
	11	7	1964	29.4	28.9	28.4	28.2	22.5	19.2		17.9	33.57	35.40	36.61	36.67	00.00	36.58	
	24	8	1964	30.3	30.4	29.6	26.9	21.2	18.3		18.3	32.20	32.09	32.12	36.54	36.56	36.46	
	19	9	1964	29.6	29.6	29.4	29.1	27.2	19.9		19.9	35.98	35.86	35.90	36.06	36.54	36.60	
	23	10	1964	25.2	25.2	25.2	25.2	24.7	22.3		19.4	36.53	36.54	36.58	36.52	36.46	36.48	
	12	11	1964	24.7	24.8	24.8	24.7	24.6	23.4		21.2	35.98	36.12	36.39	36.32	36.38	00.00	
	11	12	1964	22.5	22.5	22.5	22.4	22.4	22.2		18.4	36.72	36.73	36.68	36.67	36.69	36.69	
	19	1	1965	21.6	21.6	21.6	21.6	21.6	21.4		16.9	36.77	36.75	36.79	36.82	36175	36.80	
	15	3	1965	20.1	20.1	20.1	19.6	19.0	18.3		16.6	36.71	36.79	36.68	36.58	36.63	36.68	
	17	4	1965	23.1	23.1	23.1	21.7	19.2	18.3		17.7	36.45	36.52	36.32	36.36	36.24	36.45	
	23	5	1965	24.8	24.8	24.8	24.8	22.5	19.7		19.1	36.64	36.64	36.64	36.65	36.69	36.67	
	21	6	1965	26.4	26.4	25.3	23.8	20.6	19.2		19.2	36.45	36.59	36.45	36.59	36.64	36.67	
	20	8	1965	28.6	28.6	28.1	23.9	21.1	18.7		18.7	34.26	34.00	34.11	35.39	36.74	36.65	
	18	9	1965	28.5	28.5	28.1	27.5	00.0	00.0		27.3	32.34	32.38	35.17	35.90	00.00	00.00	
	30	10	1965	25.2	25.2	25.2	25.2	25.1	23.5		21.0	36.48	36.40	36.42	36.48	36.46	36.69	

Table 5. Monthly temperature and salinity observations at stations on transect 5, 1963-1965

STATION: E-49
DEPTH: 7 M
LATITUDE: 29°27' N
LONGITUDE: 92°20' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				Depth (M)								Depth (M)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
2	21	2	1963	12.6	12.4						12.1	29.78	30.95				
3	30	3	1963	20.8	20.8						20.2	30.82	30.82				
4	21	4	1963	23.2	23.1						22.8	22.40	24.69				
5	18	5	1963	26.4	26.4						26.3	29.84	29.85				
6	23	6	1963	28.3	28.3						28.3	30.94	30.93				
7	12	7	1963	29.3	29.6						28.4	25.35	27.93				
8	23	8	1963	29.9	29.9						29.9	32.07	32.07				
9	27	9	1963	25.7	25.8						26.3	32.15	31.93				
10	22	10	1963	24.8	24.7						24.6	33.27	33.25				
11	22	11	1963	20.4	20.3						19.9	33.12	33.05				
12	11	12	1963	16.2	16.2						16.0	33.99	33.96				
13	23	1	1964	9.6	9.1						10.1	31.44	31.81				
14	8	2	1964	11.9	12.2						12.8	31.88	32.89				
15	1	3	1964	13.3	13.3						13.6	00.00	31.77				
16	25	4	1964	25.9	25.5						24.5	20.93	20.81				
17	18	5	1964	25.2	25.2						25.4	23.64	23.81				
18	18	6	1964	29.3	29.3						29.2	26.02	25.99				
19	13	7	1964	28.6	28.6						28.5	27.18	27.17				
20	25	8	1964	30.4	30.3						30.0	30.35	30.38				
21	21	9	1964	28.3	28.2						28.2	31.96	31.96				
22	25	10	1964	21.2	21.3						21.3	31.86	31.79				
23	14	11	1964	22.8	22.5						22.6	30.47	30.61				
24	12	12	1964	15.0	15.1						15.4	31.38	33.01				
25	16	1	1965	16.7	16.7						16.7	33.60	33.38				
26	13	2	1965	17.3	17.3						17.3	34.18	20.18				
27	16	3	1965	16.6	15.8						15.2	35.20	20.18				
28	19	4	1965	23.7	23.8						23.5	13.64	20.87				
29	20	5	1965	26.1	26.0						25.9	27.44	27.47				
30	24	6	1965	29.2	29.1						29.0	28.44	28.78				
32	24	8	1965	28.0	28.5						29.1	29.84	29.92				
34	30	10	1965	21.5	21.5						21.5	29.78	29.72				
35	5	12	1965	15.5	17.7						18.3	00.00	30.05				

STATION: E-12
DEPTH: 14 M
LATITUDE: 29°08' N
LONGITUDE: 92°20' W

Cruise	Day	Month	Year	Temperature (°C)								Salinity (o/oo)					
				0	3	11	24	43	70	107	B	0	3	11	24	43	70
1	22	1	1963	12.1	11.9	11.8					11.9	33.24	33.13	33.14			
2	21	2	1963	13.8	13.8	14.2					14.3	31.95	32.60	34.12			
3	30	3	1963	20.4	20.3	20.2					20.2	33.91	33.82	33.93			
4	22	4	1963	23.4	23.3	22.6					20.8	31.63	31.85	33.83			
5	18	5	1963	26.8	26.8	24.4					24.0	29.15	29.22	35.85			
6	23	6	1963	28.4	28.4	28.4					26.7	31.20	31.05	31.58			
7	12	7	1963	29.6	29.4	25.8					25.6	35.83	30.76	30.21			
8	23	8	1963	30.3	30.3	30.3					30.4	32.82	32.97	34.66			
9	27	9	1963	26.8	26.8	26.8					26.8	32.80	32.70	32.97			
10	22	10	1963	25.3	25.2	25.2					25.1	34.07	33.73	33.74			
11	21	11	1963	19.9	19.9	19.9					19.8	33.47	33.48	33.54			
12	11	12	1963	16.6	16.6	16.1					16.1	34.11	34.09	33.98			
13	23	1	1964	10.6	10.4	9.9					9.9	33.38	33.40	33.56			
15	1	3	1964	13.8	13.7	13.8					14.4	33.09	32.93	33.22			
16	25	4	1964	23.0	22.9	22.7					22.4	20.89	29.98	28.92			
17	18	5	1964	25.2	25.1	25.1					25.0	00.00	00.00	00.00			
18	18	6	1964	29.2	29.1	27.7					25.4	29.24	29.70	32.43			
19	13	7	1964	28.6	28.6	28.7					26.6	27.20	27.43	35.70			
20	25	8	1964	30.4	30.0	29.7					28.1	32.73	31.17	31.92			
21	21	9	1964	28.2	28.2	28.2					28.2	32.17	32.19	32.16			
22	24	10	1964	21.7	21.7	21.2					20.8	32.03	32.23	32.30			
23	14	11	1964	22.9	22.9	22.9					22.9	34.45	34.39	34.45			
24	12	12	1964	15.0	15.3	15.8					15.8	32.58	33.89	34.05			
25	16	1	1965	16.0	16.0	16.0					16.0	33.21	33.20	33.21			
26	13	2	1965	17.4	17.4	17.4					17.4	34.49	34.48	34.50			
27	16	3	1965	16.6	16.4	16.1					16.1	33.56	35.58	34.16			
28	19	4	1965	23.2	23.2	22.6					22.6	32.06	32.01	33.25			
29	20	5	1965	25.4	25.3	25.2					25.0	33.28	33.44	33.60			
30	24	6	1965	29.4	29.3	28.6					28.5	30.48	30.50	33.34			
32	24	8	1965	28.7	28.7	29.1					29.1	30.55	30.42	31.72			
34	30	10	1965	21.6	21.7	24.0					24.5	29.78	29.85	31.60			
35	5	12	1965	17.4	17.4	18.3					18.8	33.42	33.13	33.64			

NOAA Technical Report NMFS SSRF-708

Catch and Catch Rates of Fishes Caught by Anglers in the St. Andrew Bay System, Florida, and Adjacent Coastal Waters, 1973

Doyle F. Sutherland

March 1977

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary
National Oceanic and Atmospheric Administration
Robert M. White, Administrator
National Marine Fisheries Service
Robert W. Schoning, Director

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Catch and Catch Rates of Fishes Caught by Anglers in the St. Andrew Bay System, Florida, and Adjacent Coastal Waters, 1973

DOYLE F. SUTHERLAND[1]

ABSTRACT

Anglers were interviewed on four fixed platforms in the St. Andrew Bay system and on charter boats that were fishing in the bay and adjacent coastal waters in 1973. They caught fishes of at least 54 species (not all were identified to species) in 31 families. The majority (58.0%) of the fishes that were caught from fixed platforms consisted of pinfish, *Lagodon rhomboides*, (18.2%); sea catfish, *Arius felis*, (12.2%); spotted seatrout, *Cynoscion nebulosus*, (10.0%); blue runner, *Caranx crysos*, (8.8%); and crevalle jack, *Caranx hippos*, (8.8%). On charter boats, king mackerel, *Scomberomorus cavalla*, comprised the majority of the catches (73.9%).

The average catch rates varied from 0.0 to 10.7 fish/h among anglers on fixed platforms and from 0.0 to 32.0 fish/h among charter boats. The greatest monthly average catch rates on fixed platforms were 2.2 fish/h in October at Deer Point Dam, 1.8 in October at Bailey Bridge, 1.8 in December at Hathaway Bridge, 2.3 in May at West Jetty, and 10.6 in September on charter boats. On the fixed platforms, the highest average catch rate for all months was 1.4 with squid and the lowest was 0.5 with fiddler crabs. Whole round scads and 00-squid spoons were used for bait by virtually all surveyed charter boats.

INTRODUCTION

The St. Andrew Bay system and adjacent coastal ters (Fig. 1) attract many recreational anglers. The tional fishery has not been previously assessed. A atch and catch rate survey of recreational fishing the area was conducted to provide fishery managers aseline estimates of fish availability to anglers for ting future trends. A companion study of the comrcial and recreational fishing effort for fisheries in the a was also conducted in 1973 (Sutherland, manuscript paration).

eased demand for food and sport fishes is a growing cern to fishery managers. In recent years, the lands in pounds of food fishes by anglers have amounted ut one-half the commercial landings (Deuel 1973; epartment of Commerce 1976). In the eastern Gulf Mexico, croakers exceeded all other species in nums caught, followed by spotted seatrout, catfishes, sand ut, porgies, kingfishes, and grunts (Deuel 1973). ers and seatrouts are highly regarded by the pub and are readily available to commercial and tional fishermen in estuarine habitats. The num recreational fishermen seeking those and other es is estimated to increase by 8-10% annually (Deuel 3). The number of commercial fishermen is nably limited by finfish availability and by social onomic factors that prevail in the area.

relatively nonrestricted commercial fishery for imp and for food and bait fishes exists in the St. Andrew Bay system and adjacent coastal waters. A daily bag and size limit on several species of fishes is imposed on recreational anglers.

Catch and effort data for commercial and recreational fishing in identifiable management areas are needed to achieve optimum biological yield and to resolve other resource management problems (Irby 1974). While commercial landings are documented annually, the information is of little value for management of identifiable areas, for the fishing location and fishing effort are omitted. Similarly, catch and catch rates obtained from anglers may or may not reflect the actual availability or abundance of fishes, for angling success depends on such factors as angling skill, method, bait, location, etc. Not

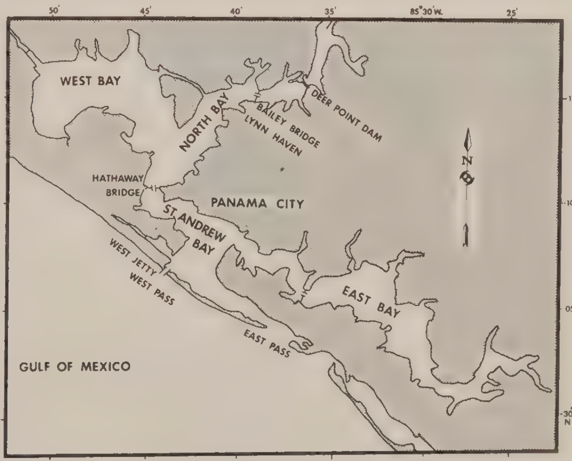

Figure 1.—St. Andrew Bay system, Fla., and adjacent coastal waters.

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east Fisheries Center Panama City Laboratory, National Marine eries Service, NOAA, P.O. Box 4218, Panama City, FL 32401.

all species of food or game fishes known to occur in St. Andrew Bay were caught by the interviewed anglers. The red snapper, *Lutjanus campechanus*, and tarpon, *Megalops atlantica*, are examples. The results from our catch and catch rate survey are presented below.

METHODS

Anglers on four fixed platforms in the St. Andrew Bay system and charter boat captains or mates who fished in the bay, inlet, and adjacent coastal waters (Fig. 1) were interviewed for catch rate data. The fixed platforms were: 1) Deer Point Dam, 2) Bailey Bridge, 3) Hathaway Bridge, and 4) West Jetty. Only charter boatmen that trolled for nearshore pelagic fishes, chiefly Spanish and king mackerels, were interviewed, since charter boats in the demersal fishery generally fish beyond 25 km offshore. More importantly, charter boatmen are exceedingly reluctant to reveal the location of their demersal fishing grounds. Most of the interviewed charter boatmen fished within 25 km of West Pass.

The creel census was conducted twice weekly by rotating the visits among the fixed platforms and charter boats. On occasions when anglers did not use the scheduled fixed platforms, additional visits were made to the marinas to obtain catch rates from charter boats. None of the fixed platforms were used by anglers on survey days in January or the charter boats in January, February, and December. In the period February through December, catch rates were obtained on 23 visits to Deer Point Dam, Bailey Bridge, and Hathaway Bridge, and on 24 visits to West Jetty and charter boats.

The catch rates obtained in this survey were from daytime angling only. Of the anglers interviewed on fixed platforms few had started fishing prior to 0600 h. Peak fishing hours were from 0900 to 1100. Similarly, relatively few of the surveyed charter boats fished prior to 0600; most fished during the hours 0600 to 1000. All f
times were recorded to the nearest one-quarter hou
survey ended at 1600 each day.

The fixed platforms were surveyed continu
throughout the day. The beginning time, catch, an
of bait were recorded for each angler. Elapsed f
time, additional catch, and bait changes were no
repeated interviews of individual anglers. Fishe
were reportedly caught and returned to the wate
classed as throwbacks; the number reported w
cepted as accurate. Observed fishes were usually
tified to species, but in some cases were identified c
family.

Charter boat captains attempted to schedule the
pelagic fishing trip each day to begin at 0600. Sinc
charters were for 4 h, peak fishing hours were fron
to 1000, although previously scheduled and nonsch
trips departed and returned to the marinas throu
the day. Catch and effort data were obtained fr
many of the returning charter boats as time and ci
stance permitted.

FISHES CAUGHT

Anglers caught at least 55 species of fishes
families (Table 1): 31 species at West Jetty,
Hathaway Bridge, 20 at Deer Point Dam, 13 at
Bridge, and 23 on charter boats. Sciaenidae contri
the greatest number of species (seven) follow
Carangidae (six); other families were represent
three or four species. Eight species of fishes const
72.9% of the total catch on fixed platforms:
(18.2%), sea catfish (12.8%), spotted seatrout (1
blue runner (8.8%), crevalle jack (8.8%), sand se
(5.9%), Atlantic croaker (4.8%), and lefteye flo
(3.6%). King mackerel constituted 73.9% of the
catch by charter boats.

Table 1.—Common and scientific names of fishes caught by anglers at four locations in St. Andrew Bay system, Fla., and in adjacent waters, 1973

Common name	Scientific name	Deer Pt. Dam	Bailey Bridge	Hathaway Bridge	West Jetty	B c v
Requiem sharks	CARCHARHINIDAE					
	Carcharhinus sp.			x	x	
Hammerhead sharks	SPHYRNIDAE					
	Sphyrna sp.		x			
Stingrays	DASYATIDAE					
	Dasyatis sp.			x	x	
Morays	MURAENIDAE					
	Gymnothorax sp.	x		x		
Lizardfishes	SYNODONTIDAE					
Inshore lizardfish	*Synodus foetens*				x	
Sea catfishes	ARIIDAE					
Sea catfish	*Arius felis*	x	x	x	x	
Gafftopsail catfish	*Bagre marinus*	x	x	x		
Toadfishes	BATRACHOIDIDAE					
Gulf toadfish	*Opsanus beta*	x	x			
Needlefishes	BELONIDAE	x			x	
Sea basses	SERRANIDAE					
Sea bass	*Centropristis* sp.			x	x	
Sand perch	*Diplectrum formosum*			x		
Gag	*Mycteroperca microlepis*				x	

Table 1.—Continued.

mmon name	Scientific name	Deer Pt. Dam	Bailey Bridge	Hathaway Bridge	West Jetty	Bay and coastal waters
nfishes	CENTRARCHIDAE					
Bluegill	*Lepomis macrochirus*	x				
ear sunfish	*Lepomis microlophus*	x				
hes	POMATOMIDAE					
B fish	*Pomatomus saltatrix*				x	x
bias	RACHYCENTRIDAE					
Cobia	*Rachycentron canadum*					x
nd pompanos	CARANGIDAE					
runner	*Caranx crysos*	x	x	x	x	x
Crevalle jack	*Caranx hippos*	x	x	x	x	x
Horse-eye jack	*Caranx latus*			x		
herjacket	*Oligoplites saurus*	x			x	x
ter amberjack	*Seriola dumerili*					x
da pompano	*Trachinotus carolinus*				x	
lphins	CORYPHAENIDAE					
Pompano dolphin	*Coryphaena equisetis*					x
hin	*Coryphaena hippurus*					x
rs	LUTJANIDAE					
Red snapper	*Lutjanus campechanus*					x
Gray snapper	*Lutjanus griseus*	x		x	x	
ilion snapper	*Rhomboplites aurorubens*				x	
	POMADASYIDAE					
tate	*Haemulon aurolineatum*				x	
Pigfish	*Orthopristis chrysoptera*	x	x	x	x	
rgies	SPARIDAE					
pshead	*Archosargus probatocephalus*	x	x		x	
sh	*Lagodon rhomboides*	x	x	x	x	x
ums	SCIAENIDAE					
Silver perch	*Bairdiella chrysura*	x	x	x		
Spotted seatrout	*Cynoscion nebulosus*	x	x	x	x	x
seatrout	*Cynoscion arenarius*	x	x	x		
	Leiostomus xanthurus	x			x	
Atlantic croaker	*Micropogon undulatus*	x	x	x	x	
Black drum	*Pogonias cromis*	x	x		x	
drum	*Sciaenops ocellata*	x				x
ishes	EPHIPPIDAE					
Atlantic spadefish	*Chaetodipterus faber*			x	x	
rrotfishes	SCARIDAE				x	
ullets	MUGILIDAE					
	Mugil sp.				x	
udas	SPHYRAENIDAE					
Great barracuda	*Sphyraena barracuda*					x
tlass fishes	TRICHIURIDAE					
ntic cutlassfish	*Trichiurus lepturus*					x
els and tunas	SCOMBRIDAE					
oo	*Acanthocybium solanderi*					x
Little tunny	*Euthynnus alletteratus*			x	x	x
King mackerel	*Scomberomorus cavalla*					x
ish mackerel	*Scomberomorus maculatus*			x	x	x
es	ISTIOPHORIDAE					
Sailfish	*Istiophorus platypterus*					x
arobins	TRIGLIDAE					
	Prionotus sp.				x	
flounders	BOTHIDAE					
	Paralichthys sp.			x	x	
iggerfishes and efishes	BALISTIDAE					
triggerfish	*Balistes capriscus*			x	x	x
ehead filefish	*Monacanthus hispidus*			x		
xfishes	OSTRACIIDAE					
Scrawled cowfish	*Lactophrys quadricornis*			x		
ffers	TETRAODONTIDAE					
hern puffer	*Sphoeroides nephelus*			x		
inefishes	DIODONTIDAE					
Striped burrfish	*Chilomycterus schoepfi*			x	x	

VARIATION IN CATCH RATES BY BAIT TYPE

Intangible differences in angling experience are recognized as a source of variation in catch rates among anglers participating in a mixed-creel sport fishery (Caillouet and Higman 1973). The anglers interviewed on the fixed platforms in the St. Andrew Bay system were particularly diverse in their selection of fishing tackle and bait and in their method of fishing. Many of the anglers were visitors who had little saltwater fishing experience or knowledge of the available species of fishes. Most still-fished with dead shrimp or squid on the bottom. The experienced anglers, in contrast, selected baits that they regarded as most effective in catching a particular species of fish. Inexperienced anglers' catches consisted mostly of demersal fishes, while experienced anglers' catches consisted of both demersal and pelagic fishes.

The relative importance of bait type to angler success (catch rate) and bait preference of 10 species of fishes were investigated. According to the catch rate data, squid was the most effective of the eight bait types used by anglers on fixed platforms. The effectiveness of that particular bait may be attributed in part to its le
like toughness and its appeal to pinfish, a specie
was usually available at all the platforms. Because
toughness, it is less easily removed from the ho
"nibblers" thus increasing fishing time by reduci
time spent rebaiting, although my personal observ
and experience indicate that fresh dead shrimp w
tract more species of fish at a faster rate than will
The highest average catch rate in any month (N
ber) was achieved by anglers using dead shrimp.
average was 4.47 fish/h (Table 2), but the catche
sisted mostly of pinfish, sea catfish, and unider
throwbacks.

The experienced angler seeking spotted seatr
highly prized food and game fish, generally fishe
either live shrimp or artificial lures. The catch ra
dicate live shrimp was 3.6 times more effective tha
(Table 3). The comperatively fast moving pelagic
such as blue runner and crevalle jack apparentl
ferred fast moving baits, as the highest catch rate
obtained by anglers using artificial lures.

The fishes that were caught and the percentage
position of the catch from each platform are preser

Table 2.—Variation in catch rates of saltwater fishes caught by interviewed anglers on fixed platforms in the St. Andrew Bay system, Fl by bait type and month. (hrs = hours of angling, c/h = average catch per hour.)

	Bait type															
			Fish						Shrimp				Artificial lure		Fi c	
	Squid		Live		Dead		Cut		Live		Dead					
Month	hrs	c/h	hrs	c/h	hrs	c/h	hrs	c/h	hrs	c/h	hrs	c/h	hrs	c/h	hrs	
Feb.	2.25	0.00	—	—	—	—	—	—	23.50	0.51	15.00	0.00	16.00	0.12	10.00	
Mar.	13.00	0.85	0.25	0.00	—	—	4.00	0.75	4.25	0.94	31.25	1.06	19.25	0.00	15.25	
Apr.	19.00	1.42	3.50	0.86	—	—	—	—	—	—	68.75	1.64	23.25	0.26	12.75	
May	12.00	3.83	6.50	4.31	—	—	17.00	0.94	—	—	66.25	1.36	31.50	0.98	—	
June	30.75	1.72	19.50	0.51	7.50	0.00	9.50	0.10	—	—	83.00	0.96	5.50	3.09	4.00	
July	52.50	1.41	—	—	2.25	0.44	47.75	0.67	1.50	0.00	120.75	0.69	7.50	0.27	3.00	
Aug.	82.25	1.08	—	—	—	—	18.25	0.27	2.00	0.00	151.00	0.84	19.75	0.05	—	
Sept.	7.00	1.14	0.25	0.00	1.00	0.00	1.50	0.00	11.75	0.59	72.00	0.40	21.00	0.38	—	
Oct.	34.75	1.12	7.25	1.10	—	—	6.00	0.50	7.00	3.28	115.25	1.29	6.00	2.50	3.50	
Nov.	15.00	1.07	3.75	0.53	5.00	2.00	21.25	1.22	25.50	1.10	21.50	4.47	42.00	2.74	10.00	
Dec.	—	—	0.75	0.00	—	—	1.00	1.00	16.50	1.82	10.25	0.88	27.25	1.47	—	
Total	268.50		41.75		15.75		126.25		92.00		755.00		219.00		58.50	
Average		1.35		1.22		1.08		0.69		1.13		1.07		1.08		

Table 3.—Average catch per hour of 10 saltwater fishes caught by interviewed anglers on fixed platforms in the St. Andrew Bay system, Fla., 1973, by bait type. (Hours of angling.)

	Bait type						
		Fish			Shrimp		
Species	Squid (268.50)	Live (41.75)	Dead (15.75)	Cut (126.25)	Live (92.00)	Dead (755.50)	Lures (219.00)
Pinfish	0.38	0.00	0.00	0.03	0.03	0.16	0.00
Sea catfish	0.24	0.00	0.00	0.03	0.00	0.13	0.00
Spotted seatrout	0.00	0.02	0.00	0.00	0.71	0.04	0.20
Blue runner	0.10	0.00	0.06	0.10	0.00	0.09	0.12
Crevalle jack	0.04	0.00	0.00	0.00	0.00	0.01	0.41
Sand seatrout	0.00	0.00	0.00	0.09	0.00	0.06	0.00
Atlantic croaker	0.04	0.02	0.00	0.02	0.00	0.06	0.01
Flounder	0.01	0.14	0.00	0.02	0.00	0.00	0.11
Tomtate	0.03	0.00	0.00	0.00	0.16	0.00	0.00
Spadefish	0.02	0.00	0.00	0.00	0.00	0.04	0.00

ables 4-8. The monthly average catches per hour from platforms are shown in Table 9.

CATCH AND CATCH RATES

Point Dam

At Deer Point Dam 236 interviewed anglers caught 20 s of fishes and unidentified throwbacks (Table 4) .0 h of angling (Table 9). In the February-Decem- r period, the catch rate averaged 1.0 fish/h of angling d ranged from 0.0 to 10.7 fish/h by individual anglers 2).

platform was frequently used by skilled anglers eking spotted seatrout, particularly during the fall and winter months. As a result of that effort, the spot- atrout was the most commonely caught fish, amount- 21.0% of the total catch. Pinfish and throwbacks mprised 39.3% of the total catch.

y Bridge

The catch at Bailey Bridge consisted of 13 species of (Table 5). They were caught by 99 interviewed s in 147.5 h of angling for an average catch rate 1.2 fish/h in the 11-mo period of February through cember (Table 9). Individual catches ranged from 0.0 fish/h (Fig. 2).

ey Bridge, like Deer Point Dam, was a favored atform for spotted seatrout anglers, particularly in late mmer through early winter. Of the fishes that were t, 37.1% consisted of this species. Pinfish, sea cat- nd throwbacks comprised 36.6% of the catch.

Hathaway Bridge

The old Hathaway Bridge with its removed center span serves as two public fishing piers. Located alongside U.S. Route 98, it is easily found by visiting anglers. The majority of the interviewed anglers were thought to be visitors to this area.

The catch by both resident and nonresident anglers consisted of 27 species of fishes (Table 6). The number of interviewed anglers was the highest and the average catch rate the lowest of the surveyed platforms. On that platform, 436 interviewed anglers fished 757.0 h and averaged 0.9 fish/h during a 10-mo period, March through December (Table 9). Individual catch rates ranged from 0.0 to 10.2 fish/h.

Pinfish, sea catfish (usually discarded), and throwbacks accounted for 55.0% of the catch. The sand seatrout, one of the more popular fishes at the Hathaway Bridge, was available throughout most of the year and accounted for 12.6% of the total catch.

West Jetty

The West Jetty, accessible through St. Andrew State Park and by boat, is used extensively by both resident and nonresident anglers. Located at the inlet to St. Andrew Bay, the jetty provides the angler with a platform to fish for estuarine and oceanic fishes simultaneously. The rocky jetty and strong current through the inlet is the nemesis of the inexperienced angler, particularly those that attempt to fish for bottom fish. For that kind of fishing, a heavy weight, which is frequently fouled in the rocks on retrieval, is required. Many of the anglers who

.—Monthly catch of fishes by 236 interviewed anglers at Deer Point Dam, 1973. (No anglers were present at Deer Point Dam on survey days during January.)

	Month (number of anglers)												
	F(10)	M(15)	A(28)	M(13)	J(32)	J(28)	A(21)	S(13)	O(20)	N(28)	D(28)	Sum	Percent
otted seatrout		6	3		16	2		7	1	24	29	88	21.0
nfish			7	8	14				31	19	8	87	20.7
back*			1	8	3	25	22	2	6	5	6	78	18.6
fish			2	1	3	26	9		13			54	12.8
uegill			27									27	6.4
ver perch			11	3	6						1	21	5.0
			11	2	5							18	4.3
nner				1	9							10	2.4
c croaker			2	2	2	2				1		9	2.2
evalle jack									2		5	7	1.7
gfish				1					2	1		4	1.0
rum					2	1						3	0.7
apper									1	1	1	3	0.7
d drum	1									1		2	0.5
atherjacket				1	1							2	0.5
eepshead		1										1	0.2
sunfish			1									1	0.2
psail catfish									1			1	0.2
nd seatrout											1	1	0.2
edlefish*									1			1	0.2
*									1			1	0.2
l	1	7	65	27	61	56	31	9	59	52	51	419	99.9

*Species unknown.

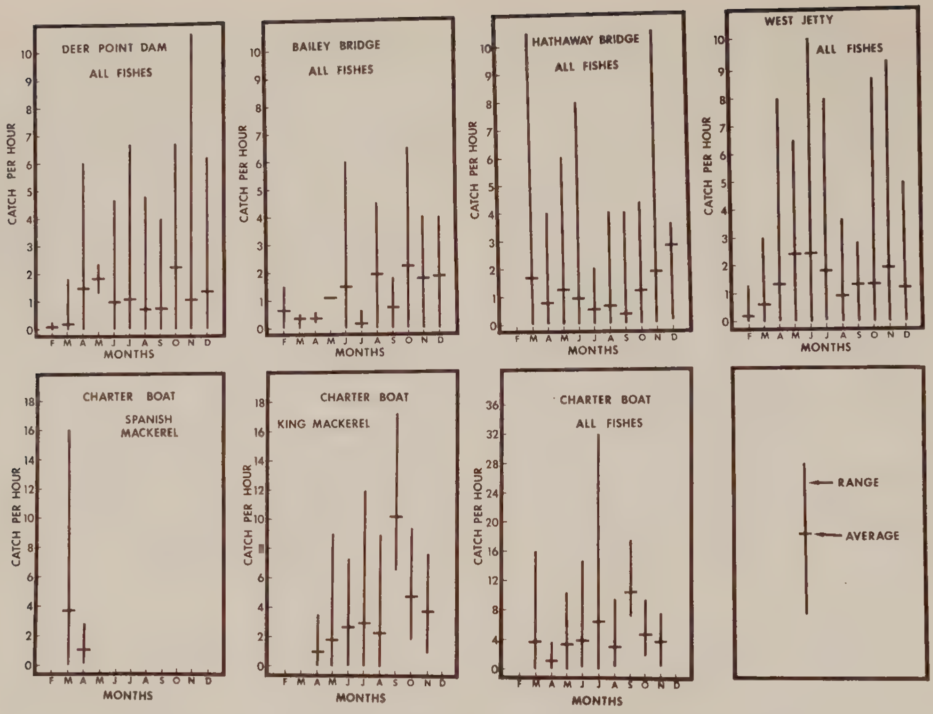

Figure 2.—Monthly range and average catch per hour of fishes by anglers on fixed platforms and charter boats in St. Andrew Bay system, Fla., and adjacent coastal waters, 1973.

were questioned about their fishing activity were not included in this survey, because most of their effort was spent replacing terminal tackle lost in the rocks.

The largest number (31) of species of food and game fishes that were caught from all platforms was available at the jetty (Table 7). The highest average catch rate from all platforms was also at the jetty. In the period February-December, an average catch rate of 1.3 fish/h was achieved by 419 fishermen in 748.0 h of angling (Table 9). The average catch rate for individuals ranged from 0.0 to 10.0 fish/h (Fig. 2).

Charter Boats

Charter boat anglers used similar tackle, baits fishing methods. Most trolled four lines, two wei and two unweighted, irrespective of the numbe anglers onboard. A 00-squid spoon or a similar spoo commonly used for Spanish mackerel, and tande consisting of three 5/0-hooks baited with a whole scad were standard for king mackerel. Because o high degree of standardization, the catch and effort c be averaged (Ricker 1958) to derive meaningful indi

Table 5.—Monthly catch of fishes by 99 interviewed anglers at Bailey Bridge, 1973. (No anglers were present at Bailey Bridge on surve during January.)

Species	Month (number of anglers)											Sum	P
	F(7)	M(11)	A(4)	M(2)	J(8)	J(14)	A(14)	S(5)	O(6)	N(19)	D(9)		
Spotted seatrout	6						7	5	7	10	30	65	
Throwback*					1		29		6	3		39	
Pinfish			3	1						11		15	
Sea catfish				1	1	2	5			1		10	
Sheepshead		5	2							3		10	
Black drum					9							9	
Atlantic croaker									8	1		9	
Silver perch				3	3				1			7	
Sand seatrout										6		6	
Pigfish					1							1	
Gafftopsail catfish					1							1	
Crevalle jack											1	1	
Hammerhead*					1							1	
Gulf toadfish									1			1	
Total	6	5	5	5	17	2	41	5	23	35	31	175	

*Species unknown.

ble 6.—Monthly catch of fishes by 436 interviewed anglers at Hathaway Bridge, 1973. (No anglers were present on Hathaway Bridge on survey days during January and February.)

ecies	M(15)	A(30)	M(36)	J(29)	J(115)	A(85)	S(37)	O(53)	N(34)	D(2)	Sum	Percent
	Month (number of anglers)											
back*	24		27		50	40	2	7	8	1	157	22.8
a catfish	3		5	5	15	62	16	14		2	122	17.5
nfish	2	17		3	3	17		30	30		102	14.6
eatrout	8		4	1	3		3	46	23		88	12.6
nner			42	19	3		1	10	5		80	11.5
c spadefish				8		27					35	5.0
nd perch								6	10		16	2.3
gfish								2	13		15	2.2
h mackerel							1		11		12	1.7
c croaker	1		1		2		4	1			9	1.3
otted seatrout			9								9	1.3
ray*		1			1			4	2		8	1.1
ev le jack									7		7	1.0
erch				2					3		5	0.7
iggerfish						1		4			5	0.7
uthern puffer								4	1		5	0.7
fftopsail catfish								2	1		3	0.4
unny						1			2		3	0.4
burrfish			1	1							2	0.3
s*				2							2	0.3
ngray*								2			2	0.3
ay snapper								1			1	0.1
ead filefish								1			1	0.1
e jack				1							1	0.1
ark*						1					1	0.1
lf toadfish								1			1	0.1
d cowfish								1			1	0.1
er*								1			1	0.1
	38	18	89	42	77	149	27	137	116	3	696	99.4

Species unknown.

ailability of Spanish and king mackerel to charter at anglers.

Anglers on 125 charter boats caught 19 species of fishes e 8). The major fishing was devoted to king erel, and that fish comprised the greatest proporon of the catch (73.9%). Six species of fishes comprised of the total catch. In addition to king mackerel, were: dolphin (5.9%), Spanish mackerel (5.0%), lit- nny (3.6%), blue runner (3.0%), and bluefish .0%). The greatest number of species of fishes was t in May (12), June (11), and July (11). Only the sh mackerel was caught in March and the king ackerel in November.

The Spanish mackerel is usually among the first c fishes to appear in local waters in the spring. In the first catch was on 16 March. During the period -30 March, the catch rates showed considerable riability among the boats. Catch rates of 0.0 to 16.0 were made by individual boats. The average for all was 3.7 fish/h (Fig. 2). Through the period 4-17 ril the catches were less variable with ranges of 0.5 to h/h. The average for all boats was 1.1 fish/h, which sts a 70% decline in available fish from the 16-30 arch period.

The first catch of king mackerel in coastal waters off ndrew Bay was on 24 April and the last on 15 mber. The dates more accurately reflect the beginng and the end of the fishing season rather than the arrival and departure of the fish. An occasional report was received of a catch of king mackerel prior to 24 April and after 15 November. Unfavorable weather and sea conditions often limit charter boat fishing trips into coastal waters in early spring and winter. The reluctance of charter boatmen to pursue a particular fish for their clients unless reasonably assured of the availability of fish is also an important factor. In season, 21% of the surveyed charter boats failed to catch a king mackerel in May, 4% failed in June, 14% failed in July, and 13% failed in August; none failed to catch one or more in late April, September, October, and early November.

According to the catch rate data, king mackerel increased in availability from an average of 1.0 fish caught per hour trolling in late April to 10.2 fish/h through September (Fig. 2). In September, the average catch rate for individual boats ranged from 7.1 to 17.5 fish/h. From the September high the catch rate declined rapidly to an average of 4.8 in October and to 3.8 in early November. The charter boat fishing season ended by mid-November because of cold weather, rough sea, and lack of clients.

DISCUSSION

On-site interviews are acknowledged as being the most reliable method of obtaining angler's catch and catch rates. Bias due to recall, vanity, and other reasons are

Table 7.—Monthly catch of fishes by 419 interviewed anglers at West Jetty, 1973. (No anglers were present at West Jetty on survey day January.)

Species	Month (number of anglers)											Sum
	F(24)	M(22)	A(44)	M(25)	J(36)	J(53)	A(44)	S(29)	O(85)	N(44)	D(13)	
Throwback*			67	76	29	99	22	14	47	10		364
Crevalle jack					1			1	33	91	3	129
Pinfish			4	1	7	14	28	4	32	5		95
Flounder*			1	1				3	25	20	8	58
Blue runner				13	21	13	6		1			54
Atlantic croaker									48	4		52
Tomtate		8							19	7	5	39
Sea catfish			15			1	6	1		1		24
Inshore lizardfish										4	18	22
Little tunny			1		16	1						18
Spanish mackerel	1		2		1			3		10		17
Mullet*									16			16
Gray snapper						1			2	8	2	13
Pigfish			1	3		2			4	2	1	13
Sheepshead	6	6	1									13
Spot							10					10
Gag grouper		1	6				2					9
Florida pompano			4	3								7
Bluefish	1			2				2			1	6
Sea robin*											4	4
Stingray*			2						2			4
Gray triggerfish			1						2			3
Vermilion snapper			1			2						3
Leatherjacket				3								3
Black drum		1		1								2
Spotted seatrout			1	1								2
Parrotfish*					1					1		2
Needlefish*									1		1	2
Shark*			1									1
Atlantic spadefish				1								1
Striped burrfish				1								1
Seabass*					1							1
Total	8	16	108	106	77	133	74	28	232	163	43	988

*Species unknown.

Table 8.—Monthly catch of fishes by anglers on 125 charter boats, 1973. (No charter boats fished on survey days during January, February, and December.)

Species	Month (number of charter boats)									Sum	Percent
	M(6)	A(13)	M(14)	J(24)	J(14)	A(31)	S(7)	O(12)	N(4)		
King mackerel		25	79	235	172	299	258	266	9	1,343	73.9
Dolphin			56	36	3	12	1			108	5.9
Spanish mackerel	61	26	4		1					92	5.0
Little tunny			5	13	6	36	4	1		65	3.6
Blue runner			8	43	1	3				55	3.0
Bluefish					38					38	2.0
Amberjack*			27			7				34	1.8
Gray triggerfish				12		14	1	4		31	1.7
Ladyfish						9				9	0.5
Cobia		1	1	4			2			8	0.4
Great barracuda			3	1		3				7	0.4
Gag grouper			4	3						7	0.4
Crevalle jack		3	1	1			1			6	0.3
Shark*			3		2					5	0.3
Red drum					3					3	0.2
Wahoo			1							1	<0.1
Sailfish				1						1	<0.1
Sand perch				1						1	<0.1
Sea catfish					1					1	<0.1
Inshore lizardfish					1					1	<0.1
Atlantic cutlassfish					1					1	<0.1
Total	61	55	192	350	229	383	267	271	9	1,817	100.0

*Species unknown.

Table 9.—Monthly average catch per hour (c/h) of fishes by interviewed anglers on fixed platforms in St. Andrew Bay system, Fla., 1973. (No anglers were observed on fixed platforms in January or on Hathaway Bridge in February.)

	Deer Point Dam			Bailey Bridge			Hathaway Bridge			West Jetty		
	No. of anglers	Hours fishes	Average c/h	No. of anglers	Hours fished	Average c/h	No. of anglers	Hours fished	Average c/h	No. of anglers	Hours fished	Average c/h
	10	13.25	0.08	7	8.50	0.71	—	—	—	24	48.50	0.16
Mar.	15	27.25	0.26	11	15.25	0.33	15	22.00	1.73	22	28.75	0.56
Apr.	28	57.75	1.12	4	15.50	0.32	30	26.75	0.67	44	83.50	1.29
	13	16.50	1.64	2	4.50	1.11	36	73.75	1.21	25	45.00	2.36
	32	58.50	1.04	8	12.25	1.39	29	48.00	0.88	36	65.25	1.18
July	28	50.75	1.10	14	14.25	0.14	115	133.00	0.58	53	74.75	1.78
Aug.	21	44.00	0.70	14	21.75	1.89	85	203.00	0.73	44	79.75	0.93
	13	12.75	0.71	5	7.25	0.69	37	71.00	0.38	29	21.75	1.29
	20	34.50	1.71	6	10.50	2.19	53	112.25	1.22	85	181.25	1.28
	28	46.50	1.12	19	20.50	1.71	34	64.50	1.80	44	84.25	1.93
Dec.	28	39.25	1.30	9	17.25	1.80	2	1.75	1.71	13	35.25	1.22
	236	401.00		99	147.50		436	756.00		419	748.00	
e			1.04			1.19			0.92			1.32

nized. Such data may or may not provide an ac- e measure of the availability of fishes, however. Several factors affect angling success. Among those are the species that are sought, fishing location, bait hod), and angling effort.

2,053.5 h of angling from fixed platforms in the St. Andrew Bay system, at least 55 species of fishes were ht by the interviewed anglers. Other food or game nown to occur in the system were not caught. The tarpon (*Megalops atlantica*), red snapper (*Lutjanus campechanus*), and snook (*Centropomus* sp.) are ex- es. Those fishes are not believed to be abundant, n occasional catch would be expected. Perhaps, more importantly, none of the interviewed anglers were aware of their presence or directed their efforts specifical- them.

e caught fishes were not distributed equally throughout the study area, judging from the percentage composition and number of species landed from each rm. The spotted seatrout appeared to be available ater number at Deer Point Dam than at the other locations. The percentage of the total catch was 21.0% at Point Dam, 0.2% at West Jetty, and 0.0% in coastal s. In contrast, the crevalle jack comprised 0.3% of the catch in coastal waters, 13.1% at West Jetty, and 1.6% at Deer Point Dam. All dolphin, amberjack, great cuda, wahoo, and Atlantic cutlassfish were caught astal waters, and all tomtate and gray and vermilion snappers were caught at the West Jetty.

The catch rates also differed by bait type. The highest ge catch rate achieved by all anglers on fixed plat- for all months was with dead squid (1.4 fish/h), closely followed by live bait fish (1.2 fish/h), live shrimp fish/h), and dead shrimp (1.1 fish/h). The average rate with cut fish and fiddler crabs was 51% and respectively, of that achieved with dead squid.

According to the data on bait preference, significantly r catch rates could have been obtained by using the preferred by available fishes. The highest average catch rate for spotted seatrout, for example, was 0.7 fish/h with live shrimp. That rate was 3.6 times greater than with lures and 17.8 times greater than with dead shrimp. The highest average catch rate for crevalle jacks was with lures. That rate, 0.4 fish/h, was 10.2 times greater than with squid, the next most effective bait.

It seems apparent that the catch and catch rates obtained by this creel census are of limited value for indexing the availability of fishes to anglers on fixed platforms. The data do provide a general measure of species availability and angling success by a diverse group of anglers that probably constitute the majority of all anglers. The catch rates of Spanish and king mackerels by charter boat anglers, however, are viewed as reliable measures of their availability and relative abundance. The reliability resulted from the selection of a sample of anglers having considerable experience angling for those fishes. The captains and mates on those boats are, of course, professional anglers; their fishing methods are similar and their effort competitive.

ACKNOWLEDGMENTS

I thank F. A. Kalber, G. R. Huntsman, and J. B. Higman for reviewing this manuscript.

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☆ GPO 797-121

NOAA Technical Report NMFS SSRF-709

Expendable Bathythermograph Observations From the NMFS/MARAD Ship of Opportunity Program for 1974

Steven K. Cook and Keith A. Hausknecht

April 1977

U.S. DEPARTMENT OF COMMERCE
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Expendable Bathythermograph Observations From the NMFS/MARAD Ship of Opportunity Program for 1974

STEVEN K. COOK and KEITH A. HAUSKNECHT[1]

ABSTRACT

Results of the fourth year of operation of the NMFS/MARAD Ship of Opportunity Program (SOOP) are presented in the form of vertical distributions of temperature and horizontal distributions of sea surface temperature and salinity. Operational and data management procedures also are discussed. Included are descriptive analyses of the most dynamic transects showing the Yucatan, Loop, Florida, and Gulf Stream currents and related eddies. Also, characteristics of the cold cell of bottom water on the Atlantic continental shelf are discussed.

INTRODUCTION

midyear of 1970 a cooperative expendable bathy-
ograph (XBT) program was initiated between the
al Marine Fisheries Service (NMFS) and the
ime Administration (MARAD) of the U.S. Depart-
of Commerce (Cook 1973, 1975, 1976). The
m, conducted in support of the Marine Resources
oring Assessment and Prediction Program (MAR-
) of the NMFS, involved the use of maritime cadets
the Kings Point Maritime Academy to collect XBT
n board merchant ships operating along the east
ulf coasts of the United States. The objective of
cooperative program was to identify and describe
nal and year-to-year variations of temperature and
ation in the major current regimes of the western
al Atlantic, Caribbean Sea, Gulf of Mexico, and
rn North Atlantic, utilizing merchant ships as
vely inexpensive platforms for the collection of

AREAS OF STUDY

routes were selected to obtain regular sampling in
most dynamic areas of the Gulf of Mexico and
rn North Atlantic. The features of principal in-
were the Yucatan Current, Loop Current, Florida
nt, Gulf Stream, Shelf Water-Slope Water front,
a cold-water cell in the Middle Atlantic Bight.

TA ACQUISITION AND PROCESSING

e Ship of Opportunity effort for 1974 consisted of a
f 34 cruises—18 sailing from New Orleans, 12 from
ork, and 4 from Norfolk. Fifty-three transects of
rface temperature observations and associated surface data were obtained. A total of 739 XBT's were launched; of these 514 (70%) were considered of sufficient quality to be incorporated into the transects presented.

Subsurface temperature data were obtained by use of Sippican XBT systems. At the same time, surface water samples were collected with bucket thermometers for salinity determination ashore using a Beckman inductive salinometer calibrated with standard (Copenhagen) water at least once every 30 samples.

The XBT traces were submitted to the National Oceanographic Data Center (NODC) where they were digitized, key punched, and quality controlled. Finally, these processed data were listed in printout form and machine plotted. The plots produced by NODC were essentially camera-ready and needed little hand correcting. The few corrections necessary were made by discarding anomalous XBT observations that could not be supported by other associated data such as sea surface temperature or other nearby XBT observations. Consequently a vertical section plot may have one or two missing observations, resulting from the deletion of inaccurate subsurface data.

The fourth year of operation of the NMFS/MARAD Ship of Opportunity Program (SOOP) was enhanced by the inclusion of Coast Guard cutters as ships of opportunity. The Coast Guard cutters that occupy Ocean Weather Station HOTEL (OWSH) (lat. 37°N, long. 71°W) began taking hourly XBT observations between Norfolk, Va., and OWSH in August. This transect was occupied monthly while OWSH was being maintained, usually from August through April. We plan to resume this section when OWSH is again occupied.

Approximately 225 XBT drops and associated surface data are not included because the observations were much too widely separated in time and space to be useful in the analysis. All data collected were archived by the NODC and are available to interested persons through the NODC, Washington, D.C. 20235.

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tic Environmental Group, National Marine Fisheries Service, R.R. 7A, Box 522-A, Narragansett, RI 02882.

Further details concerning the acquisition or processing of data from the cruises considered here can be obtained from the authors.

For purposes of this report all descriptive figures have been included within the text and all vertical temperature sections have been organized geographically and chronologically and included as Appendix Figures.

TRANSECT ANALYSIS

Gulf of Mexico (Fig. 1, Appendix Figs. 1-16)

Loop Current.—In 1974 the Loop Current was crossed on seven occasions (Table 1) by SOOP ships. There were two crossings in March (Appendix Figs. 1, 2), one in April (Appendix Fig. 3), two in May (Appendix Figs. 4, 5), and one each in June (Appendix Fig. 6) and July (Appendix Fig. 8).

Utilizing 20°C at 125 m as the left edge of the Loop Current (G. A. Maul, pers. commun.), the position of the front can be monitored from XBT data. Most migrations of the Loop Current edge ranged between lat. 22°N and 24°N. Movements of more than 1° of latitude in less than 2 wk were not uncommon. One migration of about 90 nautical miles (167 km) occurred within 9 days, between 28 June (Appendix Fig. 6) and 7 July (Appendix Fig. 8).

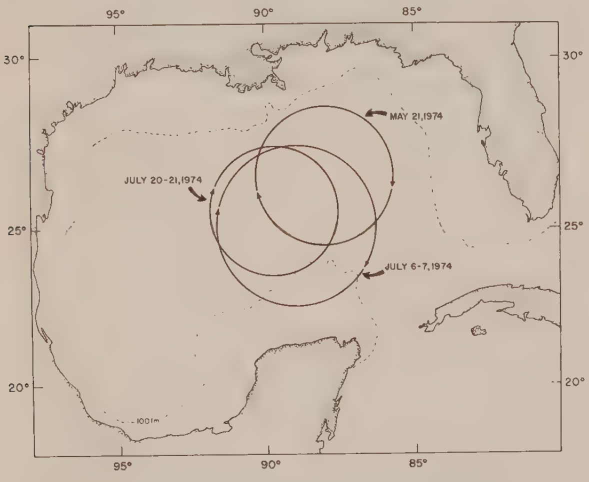


Figure 1.—Composite plot of Gulf of Mexico eddy positions.

Table 1.—Crossings of the Loop Current made by SOOP vessels in 1974.

Appendix figure	Ship	Station no.	Date
1	*Delta Sud*	20-23	8-9 Mar.
2	*Delta Norte*	11-15	21-23 Mar.
3	*Delta Sud*	28-31	15-17 Apr.
4	*Delta Sud*	40-32	21 May
5	*Delta Sud*	22-24	27-29 May
6	*Delta Sud*	9-2	28-29 June
8	*Delta Sud*	17-20	7-8 July

The Loop Current was crossed by the *Delta Sud* March at lat. 23°15′N at station 23 (Appendix Fi Again on 23 March at lat. 22°30′N the *Delta Norte* crossed the Loop Current between stations 12 and 13 (Appendix Fig. 2).

In April (Appendix Fig. 3) a crossing of the Loop rent by the *Delta Sud* determined the front to be at la 22°N.

In May (Appendix Fig. 4) the Loop Current app as a broad flowing current between stations 40 and this time the front's position had intruded up to la 24°N. Again in May (Appendix Fig. 5), the *Delta* crossed the Loop Current between stations 22 and that time the front had receded back to lat. 23°N.

In June (Appendix Fig. 6) the Loop Current again a peared as a broad flow between stations 9 and 2 main front (20°C and 125 m) showed up between sta 7 and 8 at about lat. 24°N. Also present at this time w a counterflow around Cuba that showed up betwe stations 1 and 2.

In July (Appendix Fig. 8), the Loop Current was ed at lat. 22°30′N between stations 17 and 18.

Eddies.—In 1974 the SOOP ships in the Gulf of ico crossed eddies most of which were anticyclonic w warm-cores on 19 occasions (Table 2). Eddies were cro ed in March through August and November (App Figs. 1-7, 9-14). The diameters of these eddies crossed ranged from about 75 nautical miles (138 km) 335 nautical miles (621 km) and ranged in depth 200 to 700 m. Some eddies were crossed more than One anticyclonic eddy (Appendix Figs. 4, 7, 9) in ticular was easy to track because it had a subsurface s nature in the form of a peak in the 26° isotherm tha opposite to the rest of the isotherms. This peak als pened to occur at the center of the eddy. This eddy crossed on 21 May (Appendix Fig. 4), 7 July (Appen Fig. 7), and 21 July (Appendix Fig. 9) and migra position from lat. 26°24′N, long. 87°52′W (Appendi 4) to lat. 24°55′N, long. 88°55′W (Appendix Fig. 7) lat. 25°26′N, long. 89°44′W (Appendix Fig. 9). On crossings the eddy structure extended to dept greater than 600 m. The eddy moved 140 nautical (259 km) in 2 mo in a southwesterly direction or about nautical miles (4.3 km)/day (Fig. 1).

Low salinity surface water.—River runoff along Gulf coast, which forms a plume detectable by low face salinities ($<34.5^{\circ}/_{\circ\circ}$), sometimes extended distances offshore (well beyond the shelf break). transects of low salinity water were detected in 1 (Table 3). Crossings in March, April, May, June, and August (Appendix Figs. 1, 3, 4, 6, 7, 9-12) sh large variations in salinity ranges and horizontal ex

At times the extent of the low salinity surface water the eastern Gulf of Mexico seemed to be controlled b northward migrations of either eddies or the Loop

Table 2.—Location and characteristics of eddies transected in the Gulf of Mexico by SOOP vessels in 1974.

Appendix figure	Ship	Station no.	Station coordinates (lat., long.)	Date	Depth (m)	Diameter nm (km)
1	*Delta Sud*	12	26°56′N, 91°33′W	8-9 Mar.	>500	170 (315)
		16	25°08′N, 89°21′W		>500	170 (315)
		17	24°56′N, 89°05′W		>500	120 (222)
		20	23°40′N, 87°32′W		>500	120 (222)
2	*Delta Norte*	1	27°52′N, 92°51′W	21-23 Mar.	>600	200 (370)
		5	25°09′N, 89°47′W		>600	200 (370)
		6	24°50′N, 89°28′W		>700	175 (324)
		11	22°55′N, 87°05′W		>700	175 (324)
3	*Delta Sud*	11	27°01′N, 91°51′W	15-17 Apr.	>600	95 (176)
		16	26°00′N, 90°29′W		>600	95 (176)
		16	26°00′N, 90°29′W		>600	290 (537)
		28	22°46′N, 86°30′W		>600	290 (537)
4	*Delta Sud*	40	24°29′N, 86°51′W	21 May	600	245 (453)
		49	28°09′N, 88°48′W		600	245 (453)
5	*Delta Sud*	4	27°28′N, 92°16′W	27-29 May	>600	120 (222)
		9	26°10′N, 90°48′W		>600	120 (222)
		9	26°10′N, 90°48′W		>600	300 (556)
		22	23°10′N, 86°55′W		>600	300 (556)
6	*Delta Sud*	9	25°41′N, 87°08′W	28-29 June	>500	175 (324)
		17	28°08′N, 88°52′W		>500	175 (324)
7	*Delta Sud*	4	27°17′N, 91°44′W	6-7 July	>600	335 (621)
		14	23°30′N, 87°18′W		>600	335 (621)
9	*Delta Norte*	8	27°48′N, 92°44′W	20-21 July	>600	140 (259)
		13	26°17′N, 90°54′W		>600	140 (259)
		13	26°17′N, 90°54′W		>700	195 (361)
		22	24°17′N, 88°17′W		>700	195 (361)
10	*Mayaguez*	1	29°01′N, 88°44′W	17-18 Aug.	>600	165 (306)
		7	27°22′N, 86°41′W		>600	165 (306)
11	*Mayaguez*	19	24°24′N, 82°39′W	25-26 Aug.	>700	240 (445)
		24	26°54′N, 85°53′W		>700	240 (445)
12	*Mayaguez*	1	28°44′N, 88°26′W	28-29 Aug.	>600	140 (259)
		6	27°19′N, 86°27′W		>600	140 (259)
		6	27°19′N, 86°27′W		>200	150 (278)
		9	25°37′N, 84°22′W		>200	150 (278)
13	*Delta Sud*	10	25°37′N, 87°33′W	2 Nov.	>600	[1]75 (139)
		13	26°42′N, 88°06′W		>600	[1]75 (139)
14	*Delta Sud*	21	27°36′N, 87°36′W	6 Nov.	>600	160 (296)
		26	26°07′N, 85°21′W		>600	160 (296)

[1] Only about one-half of this eddy was transected.

Table 3.—Low salinity ($< 34.5^{\circ}/_{\circ\circ}$) coastal water encountered by SOOP vessels in the northern Gulf of Mexico in 1974.

Appendix figure	Ship	Date	Station no.	Water depth at seaward edge (m)	Offshore extent nm (km)
1	*Delta Sud*	8-9 Mar.	2-4	32	50 (93)
3	*Delta Sud*	15-17 Apr.	1-4	38	70 (130)
4	*Delta Sud*	21 May	49-51	124	70 (130)
6	*Delta Sud*	28-29 June	16-18	>500	90 (167)
7	*Delta Sud*	6-7 July	1-3	144	195 (361)
9	*Delta Norte*	20-21 July	1-11	>800	230 (426)
10	*Mayaguez*	17-18 Aug.	1-3	>800	85 (157)
11	*Mayaguez*	25-26 Aug.	25-27	>800	210 (389)
12	*Mayaguez*	28-29 Aug.	1-6	>800	200 (371)

itself. The offshore extent of the low salinity surface er shown in Appendix Figures 4, 7, and 9 apparently blocked by the presence of one particular anticy- c eddy. The southwestward migration of this eddy (as discussed above) removed the block and allowed the plume to extend farther offshore. In some instances the low salinity surface waters were entrained into the eddy structure (Appendix Figs. 6, 9, 10, 12). In most cases when this occurred the low salinity water appeared on only the northern side of the eddy. Peaks in the surface salinity (Appendix Figs. 4, 9, 11, 12) indicate the instances where low salinity water was transected, exited, and then transected again, which we interpreted as low salinity surface waters being entrained by the leading edges of eddies. The interaction of coastal water with eddies probably is a significant mechanism for the mixing of the less saline coastal waters with the more saline oceanic waters in the Gulf of Mexico.

Western Atlantic Transects (Figs. 2-10 and Appendix Figs. 17-35)

Specific features that were monitored in the western North Atlantic by the program were the position of the Gulf Stream, variations in temperature and position of the bottom water cold cell on the continental shelf, position of the Shelf Water-Slope Water front, and eddies formed from the Gulf Stream. Where data were available and observations were close enough in time to permit comparison, correlations were made with the National Environmental Satellite Service (NESS) Experimental Gulf Stream Analysis (N-69) charts and *The Gulf Stream Monthly Summary* which show the positions of the Gulf Stream and associated features.

Characteristics of the bottom water cold cell.—In his discussion of temperature patterns in continental shelf water, Bigelow (1933) described a core of cold bottom water that extended from south of Long Island to the mouth of the Chesapeake and was evident throughout the summer months. According to Bigelow, this core was surrounded entirely by warmer water and could receive no replenishment during the summer; thus, he concluded it was formed in wintertime and then persisted throughout the year. Further descriptions of this cold cell have been given by Ketchum and Corwin (1964) and Whitcomb (1970). The data which are presented here show the formation, structure, and modification of this cell during 1974.

Nine observations of the cold cell were made by SOOP vessels in 1974 (summarized in Table 4). For purposes of discussion, the observations have been grouped into three separate geographic areas, chosen because th represent regularly scheduled merchant ship crui tracks. These tracks have been designated as the N MAC transect (Fig. 2), *Santa Cruz* transect (Fig. 3) HOTEL transect (Fig. 4). The MORMAC transect is t cruise track used by Moore McCormack Line ships a closely follows a line between New York and Bern The *Santa Cruz* transect extends from New York to Hatteras, approximately along long. 74°W. The HOT transect is the cruise track used by Coast Guard cu operating between Norfolk and OWSH. In the follo discussion, the seasonal characteristics and variations the cold cell temperature and position along each tra sect are summarized.

The temperature structure of water on the contin shelf during February (Appendix Fig. 17) should be co sidered, because the cold cell was formed from the waters and the minimum temperature that could b tained in the cell was dependent upon conditions d the winter months. At this time, cold water (7°-12°C) e tended from surface to bottom on the shelf and the s ture of the cell had not yet been established by strat tion.

Along the MORMAC transect, the first evidence th the cell had formed was obtained on 6 May (Appe Fig. 21). The characteristic shape of the cell was s by the outline of the 11°C isotherm in shelf wate Within this "cell-like" structure, temperatures rang from less than 9° to 11°C and the cell extended fr minimum bottom depth of 20 m to a maximum of The horizontal extent was 65 nautical miles (120 km) a the cell was approximately 20 m thick at the ce When next observed on 14 August (Appendix Fig temperatures in the cell ranged from less than 9° to and the bottom depth range of 40-55 m indicated that t cell was migrating into deeper water. The last o vation was made on 3 October (Appendix Fig. 30) this time, temperatures had warmed to 14°C in the ou edges of the cell and it had moved over the shelf bre The depth range extended from 34 to 99 m. T changes in temperature and depth are summariz Figure 2.

Along the *Santa Cruz* transect the earliest o vation of the cold cell was made on 6 May (Appendix

Table 4.—**Characteristics of the bottom water cold cell detected by SOOP vessels in 1974.**

Transect	Ship	Date	Appendix figure	Minimum bottom depth (m)	Maximum bottom depth (m)	Depth at center (m)	Approximate thickness at center (m)	Temperature range (°C)	Horizonta extent nm (kn
A	*Santa Cruz*	6 May	20	28	41	35	18	< 8-9	68 (126
B	*Mormac Argo*	5-6 May	21	20	38	29	20	< 9-11	65 (120)
C	*Santa Cruz*	11-12 June	23	32	49	45	23	< 9-13	100 (185
D	*Mormac Rigel*	14 Aug.	25	40	55	50	23	< 9-13	53 (9
E	*Santa Cruz*	3-4 Sept.	27	45	70	50	19	< 9-14	90 (16
F	USCGC *Taney*	29-30 Sept.	28	40	55	50	15	< 12-15	15 (28)
G	*Export Defender*	1 Oct.	29	40	63	60	22	< 12-16	29 (54)
H	*Mormac Rigel*	3 Oct.	30	34	99	72	30	< 11-14	110 (20
I	*Santa Cruz*	9-10 Oct.	31	45	70	50	20	< 12-14	75 (13

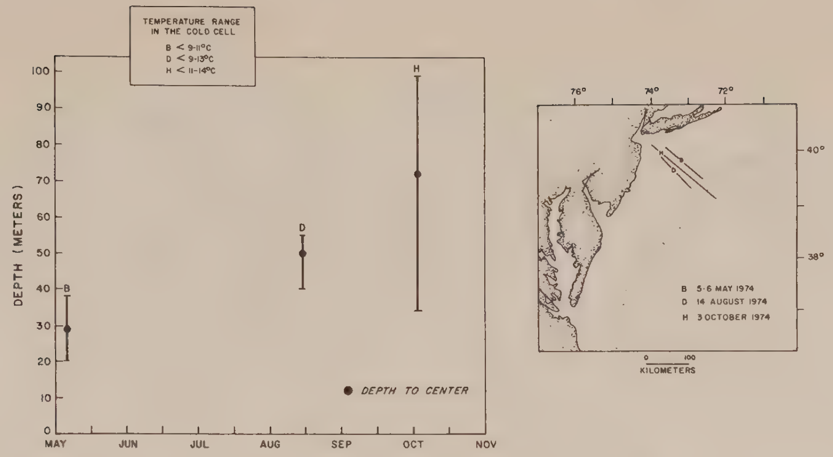


Figure 2.—Variations in cold cell temperature and depth along the MORMAC transect—May, August, and October of 1974.

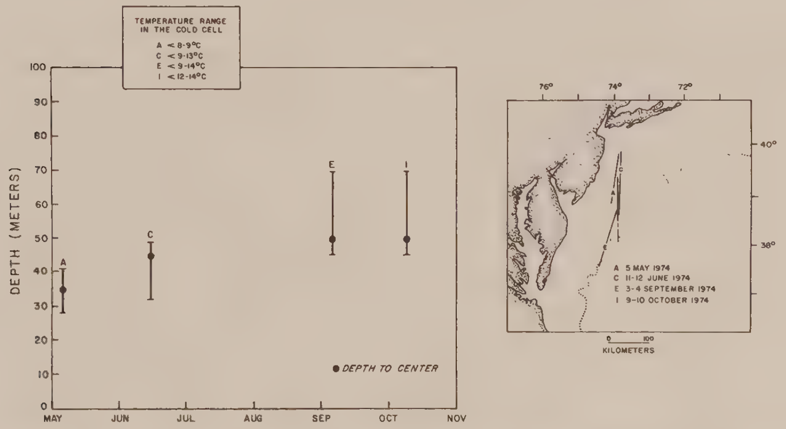


Figure 3.—Variations in cold cell temperature and depth along the *Santa Cruz* transect—May, June, September, and October of 1974.

Temperatures in the cell ranged from less than 8° to
The horizontal extent was 68 nautical miles (126
and the cell ranged from 28 to 41 m in bottom depth
a thickness of about 18 m at the center. By 11-12
(Appendix Fig. 23) the outer fringes of the cell had
ned to 13°C and water with temperatures from 10°
°C had begun to move seaward over the shelf break.
bottom depth range at this time was 32-49 m.
in the cell, two separate parcels of water (< 9°C)
present between stations 26 and 30. On 3-4 Sep-
er (Appendix Fig. 27) temperatures in the cell were
9°-14°C range and part of the cell had moved over
helf break and extended to a depth of 70 m. The ton-
ke shape of the 13° and 14°C isotherms showed the
l stages of a process called "calving" by Cresswell
) whereby a parcel of water separates from the
nt mass and moves seaward. During 9-10 October
endix Fig. 31) the calving process was detected in an
nced stage. A mass of water with temperatures rang-
om 12° to 14°C had separated from the cell on the
shelf and was moving seaward over the shelf break. At this time, the cell extended to a maximum bottom depth of 70 m. These changes in temperature and depth are summarized in Figure 3.

Only two observations of the cold cell were made along the HOTEL transect, and these were closely spaced in time—29-30 September (Appendix Fig. 28) and 1 October (Appendix Fig. 29). Appendix Figure 28 shows temperatures ranging from less than 12° to 15°C in the cell over a bottom depth range of 40-55 m. The horizontal extent was only 15 nautical miles (28 km). Slightly further south, the temperatures ranged from less than 12° to 16° over a bottom depth range of 40-63 m (Appendix Fig. 29). Here the horizontal extent was 29 nautical miles (54 km). The changes in temperature and depth are summarized in Figure 4.

Several generalizations can be made from a composite plot of the changes in cold cell temperature and depth with Figure 5. Minimum temperatures within the cell remained low (8°-9°C) throughout the summer and

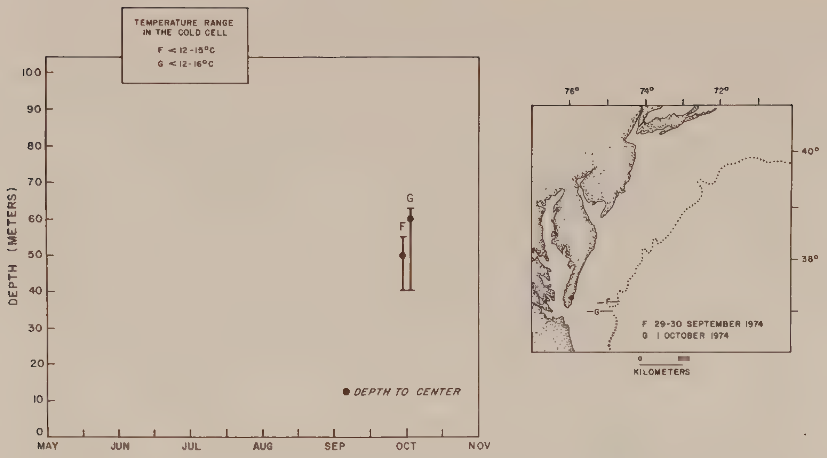


Figure 4.—Variations in cold cell temperature and depth along the HOTEL transect—September and October of 1974.

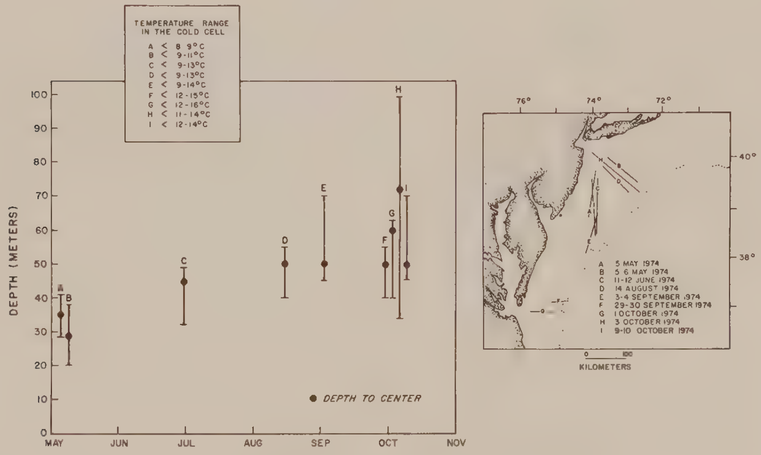


Figure 5.—Composite plot of cold cell temperature and depth—May, June, August, September, and October of 1974.

elevated temperatures were not observed until the end of September. The cold water was found in relatively shallow depths (20-40 m) in the spring, but as warming of shelf waters increased during the summer, the cell moved into deeper water. Observations made in the fall also indicated that the cell covered a greater depth range than in the spring. There seemed to be an increase in the minimum cell temperature from north to south, but there were not sufficient data to separate geographic variations from those caused by seasonal changes. A more detailed analysis would require more frequent observations made at regular intervals.

Gulf Stream.—Considerable attention has been focused on fluctuations in the position of the Gulf Stream. In addition to shipboard observations of temperature and salinity, satellite and aircraft observations of surface temperature are being used to differentiate between water masses. Because the SOOP transects intersect the Gulf Stream at discrete points with considerable spatial and temporal separation, complete coverage of the Stream and associated features by this means is im sible. However, when correlated with the satellite obs vations the transect data provide a source of gr truth for the remote sensors, as well as valuable su face information for investigators involved in study of Gulf Stream system and other water masses.

During 1974, SOOP transects crossed the Gulf St 12 times. These crossings are summarized in Figure and Table 5. Gulf Stream crossings were identified the strong horizontal gradients shown on vertical te perature sections and positions of the North Wall determined by using the 15°C isotherm at 20 (Worthington 1964).

Both *The Gulf Stream Monthly Summary* and NESS Experimental Gulf Stream Analysis (N-69) c provide information about fluctuations in the Stream position. The information provided in these p lications gives more complete and synoptic coverage the entire Gulf Stream system than is possible thr

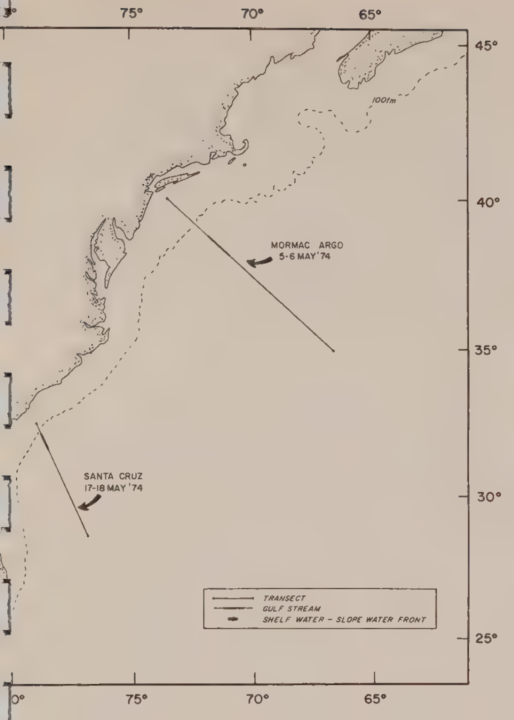

75°
70°
65°
45°
40°
35°
30°
25°
100fm
MORMAC ARGO
5-6 MAY '74
SANTA CRUZ
17-18 MAY '74
TRANSECT
GULF STREAM
SHELF WATER - SLOPE WATER FRONT

Figure 6.—Gulf Stream crossings—May 1974.

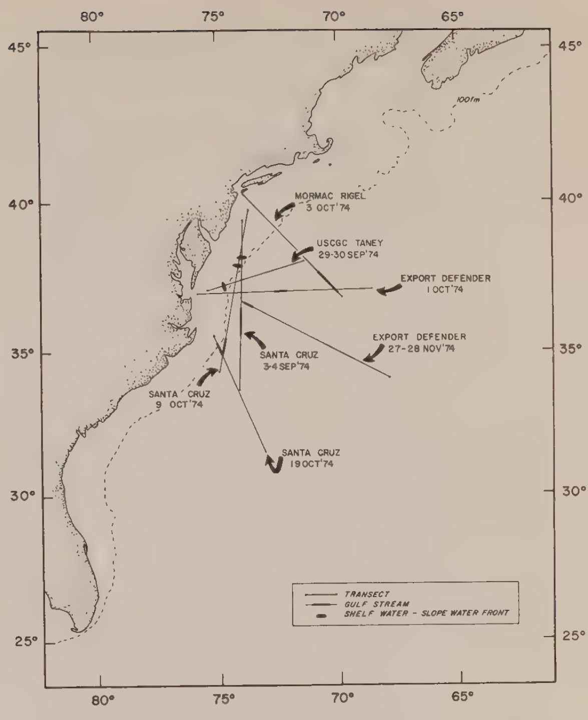
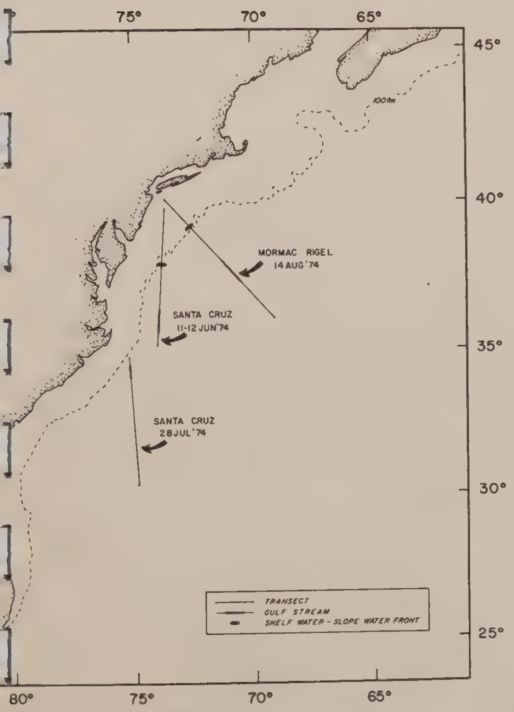

80°
75°
70°
65°
45°
40°
35°
30°
25°
100fm
MORMAC RIGEL
3 OCT '74
USCGC TANEY
29-30 SEP '74
EXPORT DEFENDER
1 OCT '74
EXPORT DEFENDER
27-28 NOV '74
SANTA CRUZ
3-4 SEP '74
SANTA CRUZ
9 OCT '74
SANTA CRUZ
19 OCT '74
TRANSECT
GULF STREAM
SHELF WATER - SLOPE WATER FRONT

Figure 8.—Gulf Stream crossings and Shelf Water-Slope Water front positions—September-November 1974.


75°
70°
65°
45°
40°
35°
30°
25°
80°
100fm
MORMAC RIGEL
14 AUG '74
SANTA CRUZ
11-12 JUN '74
SANTA CRUZ
28 JUL '74
TRANSECT
GULF STREAM
SHELF WATER - SLOPE WATER FRONT

Gulf Stream crossings and Shelf Water-Slope Water front positions—June-August 1974.

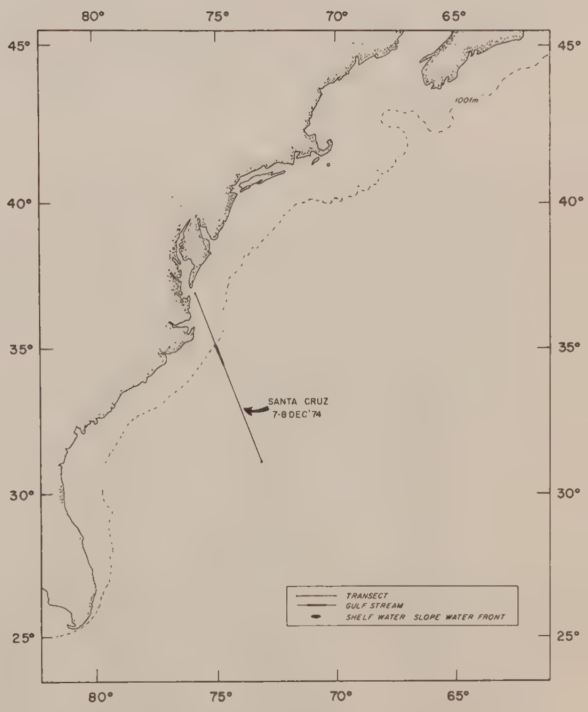

80°
75°
70°
65°
45°
40°
35°
30°
25°
100fm
SANTA CRUZ
7-8 DEC '74
TRANSECT
GULF STREAM
SHELF WATER SLOPE WATER FRONT

Figure 9.—Gulf Stream crossings—December 1974.

Table 5.—Gulf Stream crossings by SOOP vessels in 1974.

Appendix figure	Ship	Date	Position (lat., long.)
21	*Mormac Argo*	5-6 May	38°30'N, 71°12'W
22	*Santa Cruz*	17-18 May	31°48'N, 79°06'W
23	*Santa Cruz*	11-12 June	38°12'N, 73°57'W
24	*Santa Cruz*	28 July	34°48'N, 75°24'W
25	*Mormac Rigel*	14 Aug.	37°42'N, 70°48'W
27	*Santa Cruz*	3-4 Sept.	35°30'N, 75°00'W
29	*Export Defender*	1 Oct.	36°42'N, 72°18'W
30	*Mormac Rigel*	3 Oct.	37°30'N, 71°00'W
31	*Santa Cruz*	9-10 Oct.	36°12'N, 74°12'W
32	*Santa Cruz*	19 Oct.	35°00'N, 75°00'W
34	*Export Defender*	27-28 Nov.	36°00'N, 74°00'W
35	*Santa Cruz*	7-8 Dec.	36°00'N, 75°18'W

SOOP transects. However, since the N-69 charts are derived solely from remote sensing of sea surface temperatures and *The Gulf Stream Monthly Summary* is at least partially dependent upon these data, the patterns shown by these publications may not be as accurate as those portrayed from subsurface temperature data. The information collected by the SOOP affords an excellent source with which these data can be verified.

Table 6 shows the Gulf Stream positions as determined from each source. In each case, the distance has been measured along identical bearing lines and this distance converted to nautical miles. Several sources of error were apparent. The inconsistent quality of reproduction of N-69 charts and the distortion introduced by photocopying lead to some uncertainty in measurements. In addition, some interpolation was necessary to locate positions between stations on vertical sections. Interpolation was also necessary to determine positions during mid-month from *The Gulf Stre* *Monthly Summary* because positions were given only the beginning and end of the month. An estimate of errors accompanies each measurement.

Within the estimated range of measurement errors, sources agreed closely on the positions of the Gulf Stre North Wall. Only in May was there a significar ference in the measurements. The distance offsh the North Wall measured from *The Gulf Stre* *Monthly Summary* was about 40 nautical miles gre than the distance determined from SOOP data superimposed on the N-69 charts.

Eddies.—From analysis of the vertical section tained in this report, four Gulf Stream eddies w detected during 1974 (see Table 7 and Fig. 10). Ed (Appendix Fig. 19) was crossed by *Santa Cruz* May and was centered at station 7 (lat. 32°00'N, 75°00'W). The sloping of the isotherms indicated asymmetrical cold core eddy, possibly becomin trained in the Gulf Stream. *The Gulf Stream M* *Summary* (April) showed an eddy centered at 33°00'N, long. 74°00'W on 30 March 1974. Since the e was not shown in the May issue, it may have becor trained during the interval. This eddy was not sho the N-69 charts.

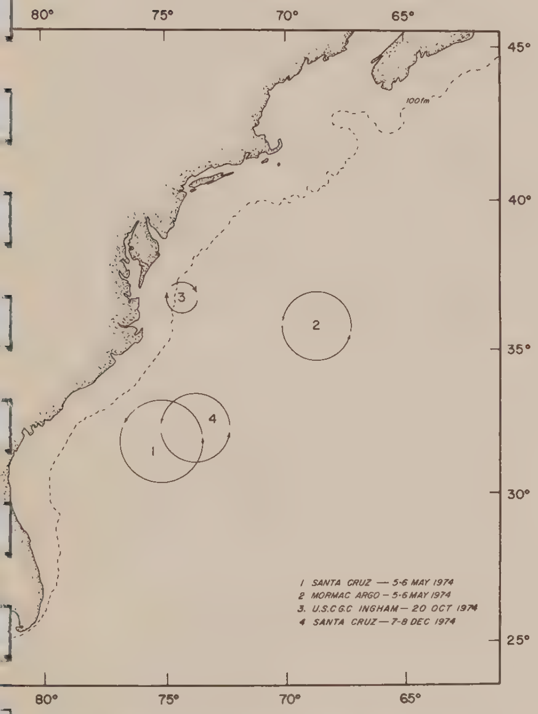
On 5-6 May (Appendix Fig. 21) *Mormac Argo* cross cyclonic, cold core eddy (Eddy #2) that was cer around station 8 (lat. 36°00'N, long. 68°00'W) structure of the eddy was evident to a depth of about m and the width at the surface where transected w proximately 145 nautical miles (269 km). The May

Table 6.—Comparison of Gulf Stream position in 1974 as located by SOOP, NESS N-69 charts, and *The Gulf Stream Monthly Summary*.

			N-69 Charts		Gulf Stream	
Appendix figure/date	SOOP bearing line	Distance nm (km)	Date/Bearing line	Distance nm (km)	Date/Bearing line	Distance nm (km)
21 5-6 May	Sandy Hook 130°	171±12 (317±22)	4-7 May Sandy Hook 130°	155±35 (287±65)	May Sandy Hook 130°	235±10 (435±19)
22 17-18 May	Charleston 147°	87±10 (161±19)	Cloud Cover	—	May Charleston 147°	34±12 (156±22)
23 11-12 June	Cape Charles 124°	118±15 (219±28)	6-10 June Cape Charles 124°	90±15 (167±28)	June Cape Charles 124°	100±18 (185±33)
24 28 July	Cape Charles 170°	140±25 (259±46)	Cloud Cover	—	July Cape Charles 170°	144±10 (267±19)
25 14 Aug.	Sandy Hook 137°	222±15 (411±28)	15-20 Aug. Sandy Hook 137°	225±10 (417±19)	August Sandy Hook 137°	215±24 (398±44)
27 3-4 Sept.	Cape Charles 161°	132±15 (245±28)	4-10 Sept. Cape Charles 161°	120±10 (222±19)	September Cape Charles 161°	115±10 (213±19)
29 1 Oct.	Cape Charles 95°	174± 6 (322±11)	27 Sept.-1 Oct. Cape Charles 95°	165±15 (306±28)	October Cape Charles 95°	150±10 (278±19)
30 3 Oct.	Sandy Hook 137°	225± 6 (417±11)	4-6 Oct. Sandy Hook 137°	230±20 (426±37)	October Sandy Hook 137°	210±10 (389±19)
31 9-10 Oct.	Cape Charles 128°	120±20 (222±37)	11 Oct. Cape Charles 128°	95±10 (176±19)	October Cape Charles 128°	120±10 (222±19)
32 19 Oct.	Cape Charles 161°	120±10 (222±19)	18-22 Oct. Cape Charles 161°	120±15 (222±28)	October Cape Charles 161°	125±12 (232±22)
34 27-28 Nov.	Cape Charles 140°	102± 6 (189±11)	21-24 Nov. Cape Charles 140°	91±15 (169±28)	November Cape Charles 140°	100±10 (185±19)
35 7-8 Dec.	Cape Charles 163°	100±50 (185±93)	5-10 Dec. Cape Charles 163°	135±12 (250±22)	December Cape Charles 163°	121±10 (224±19)

Table 7.—Gulf Stream eddies transected by SOOP vessels in 1974.

Eddy number	Appendix figure/ Date	Location of center (lat., long.)	Approximate surface diameter nm (km)	Maximum observed depth (m)	Direction of rotation
1	19 5 May	32°N, 75°W	165 (306)	650	Cyclonic
2	21 5-6 May	36°N, 68°W	145 (269)	500	Cyclonic
3	33 20 Oct.	37°N, 74°W	90 (167)	450	Anticyclonic
4	35 7-8 Dec.	32°N, 73°30′W	150 (278)	660	Cyclonic


80°
75°
70°
65°
45°
40°
35°
30°
25°
100fm
1
2
3
4
1 SANTA CRUZ — 5-6 MAY 1974
2 MORMAC ARGO – 5-6 MAY 1974
3. U.S.C.G.C INGHAM – 20 OCT 1974
4 SANTA CRUZ — 7-8 DEC 1974

igure 10.—Gulf Stream eddies surveyed during 1974.

he Gulf Stream Monthly Summary showed a onic eddy with a width of about 80 nautical miles km) centered at a position of lat. 36°30′N, long. ′W, which corresponded closely to the position of y #2. No correlation could be made with the NESS charts of 4-7 May 1974 because of heavy cloud in the study area. However, the 14 May 1974 N-69 s showed a cold-water intrusion in this area. Comson of SOOP original XBT traces with other traces n in *The Gulf Stream Monthly Summary* revealed hable similarity; it was concluded that Eddy #2 was ame eddy depicted in the May summary.

ppendix Figure 21 also showed another unusual re. An unusually strong thermal gradient (surface eratures changed from 23° to 20°C over a distance nautical miles or 28 km) was present between ons 3 and 4. Similar fronts in the Sargasso Sea have described by Katz (1969), Voorhis (1969), and Voornd Hersey (1964).

Eddy #3 (Appendix Fig. 33) was located by USCGC *Ingham* on 20 October 1974. This anticyclonic eddy was centered near lat. 37°N, long. 74°W with the characteristic downwarping of the isotherms being detectable between stations 3 and 7. An intrusion of warm water shown on the 23-28 October and 31 October-3 November N-69 charts could have been the result of this warm eddy moving into this region. However, no eddy was shown at this location in the October or November issues of *The Gulf Stream Monthly Summary*.

Eddy #4 (Appendix Fig. 35), a cold core, cyclonic eddy, was crossed by *Santa Cruz* on 7-8 December 1974. The maximum depth observed by XBT was 660 m, while the eddy center was located around lat. 32°00′N, long. 73°30′W (station 14). Sea surface temperatures were as much as 3°C lower than adjacent Gulf Stream waters, but no signature was detectable in the surface salinities. This eddy was apparently the same one that was monitored with neutrally buoyant floats by the U.S. Naval Oceanographic Office and surveyed on 11 December 1974 by P. L. Richardson aboard RV *Trident* (Gemmill 1974; Anonymous 1975; Gemmill and Cheney 1975).

Shelf Water-Slope Water front.—SOOP transects crossed the Shelf Water-Slope Water front five times during 1974. Determinations of frontal crossings were made primarily on the basis of subsurface temperature gradients shown on the vertical sections with additional supporting evidence being drawn from surface temperature and salinity gradients. A summary of these crossings is given in Table 8 and in Figures 6-9.

In order to provide a means of verification of the position of the front as determined from SOOP sections, comparisons have been made with NESS N-69 charts. After the position of the front was determined on the

Table 8.—Shelf Water-Slope Water front crossings by SOOP vessels in 1974.

Appendix figure	Ship	Date	Frontal position (lat., long.)
23	*Santa Cruz*	11-12 June	38°N, 71°48′W
25	*Mormac Rigel*	14 Aug.	39°42′N, 73°W
27	*Santa Cruz*	3-4 Sept.	38°N, 74°W
28	USCGC *Taney*	29-30 Sept.	37°N, 75°W
31	*Santa Cruz*	9-10 Oct.	38°18′N, 73°54′W

Table 9.—Comparison of position of Shelf Water-Slope Water front as detected by SOOP and N-69 charts.

Appendix figure	Date	SOOP bearing line	Distance nm (km)	Date	N-69 bearing line	Distance nm (km)
23	11-12 June	Cape Charles 53°	132±15 (245±28)	13-18 June	Cape Charles 53°	156±18 (289±33)
25	14 Aug.	Sandy Hook 141°	72±15 (133±28)	12 Aug.	Sandy Hook 141°	90±10 (167±19)
27	3-4 Sept.	Cape Charles 53°	108±12 (200±22)	Cloud cover in study area—no measurement possible		
28	29-30 Sept.	Cape Charles 86°	66±10 (122±19)	27 Sept.- 1 Oct.	Cape Charles 86°	66±12 (122±22)
31	9-10 Oct.	Cape Charles 53°	132±20 (245±37)	11 Oct.	Cape Charles 53°	102±10 (189±19)

SOOP sections, a bearing line was established to a nearby landmark. The distance in nautical miles was measured with a pair of dividers and an estimate of error was made. The position of the front was then measured along the same bearing line on the N-69 charts. These comparisons are shown in Table 9.

Within the estimated range of measurement error, the positions determined from the two sources agreed closely, suggesting that the methods currently used are reliable indicators of the frontal position.

ACKNOWLEDGMENTS

Appreciation is extended to the Maritime Academy Training representatives M. Chichurel and A. Finley in New York and D. Thompson in New Orleans, La. Their diligent efforts to place midshipmen on board ships that were scheduled to traverse preselected oceanic areas were instrumental to the success of this program. Also, thanks are extended to H. O. Travis and the National Maritime Research Center (NMRC) for their support in expanding the SOOP effort. In addition, thanks are extended to the Moore McCormack Lines and Grace Prudential Lines of New York and the Delta Steamship Company and Sea Land Shipping Lines of New Orleans. Finally, appreciation is accorded to the Marine Science Branch, Commander Atlantic Area, U.S. Coast Guard, and to the officers and crews of the USCGC *Ingham* and USCGC *Taney*.

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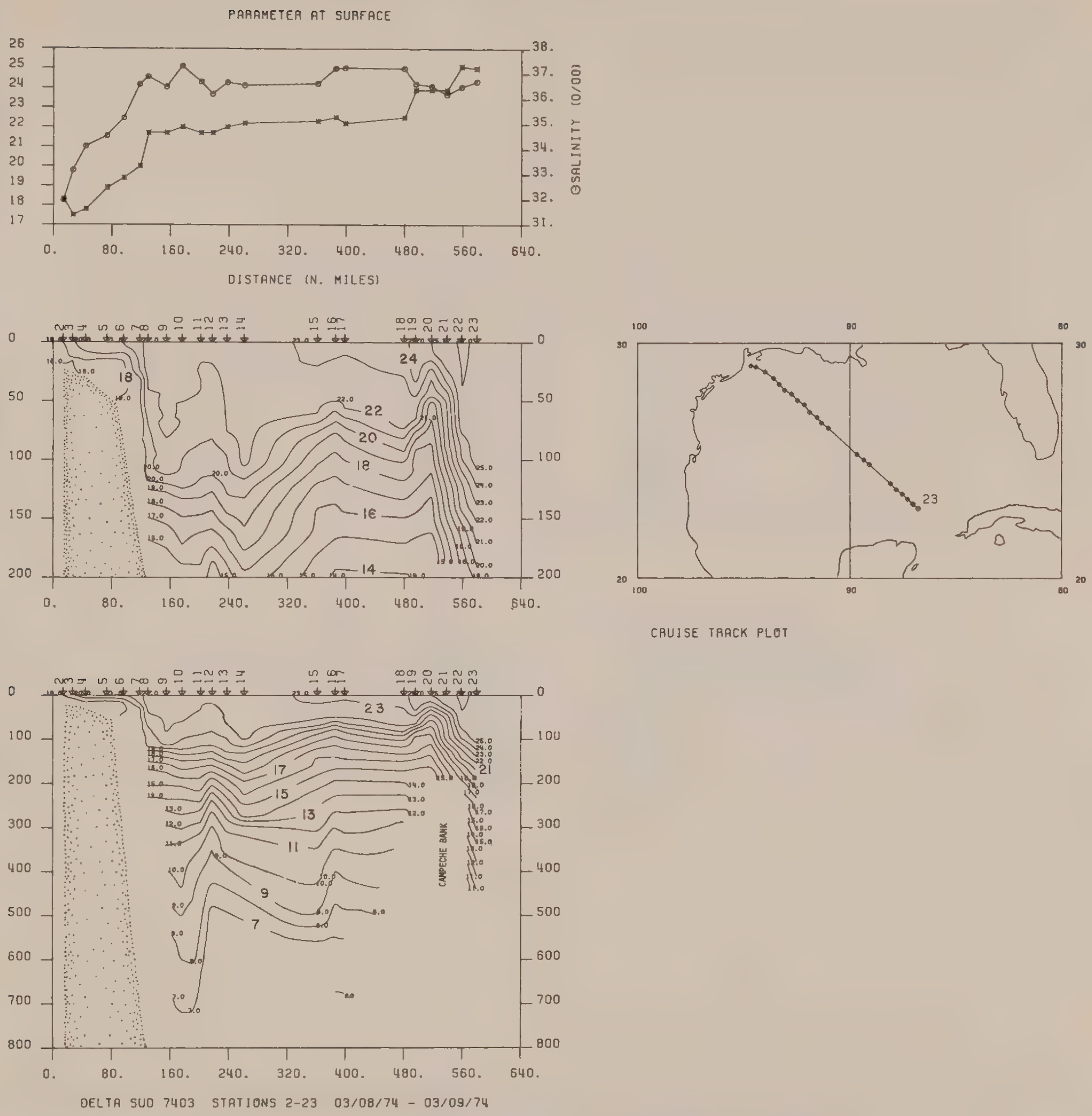
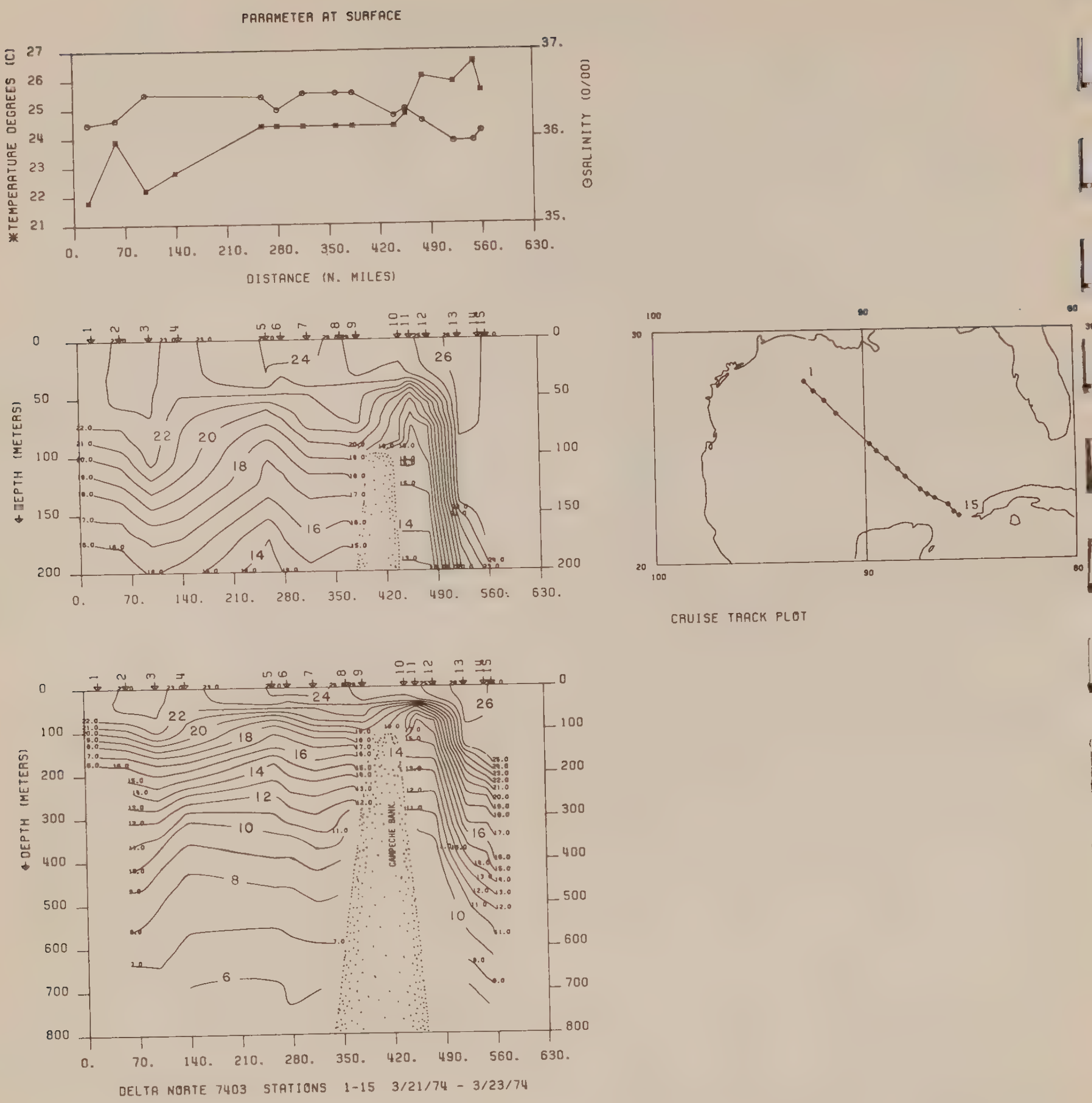
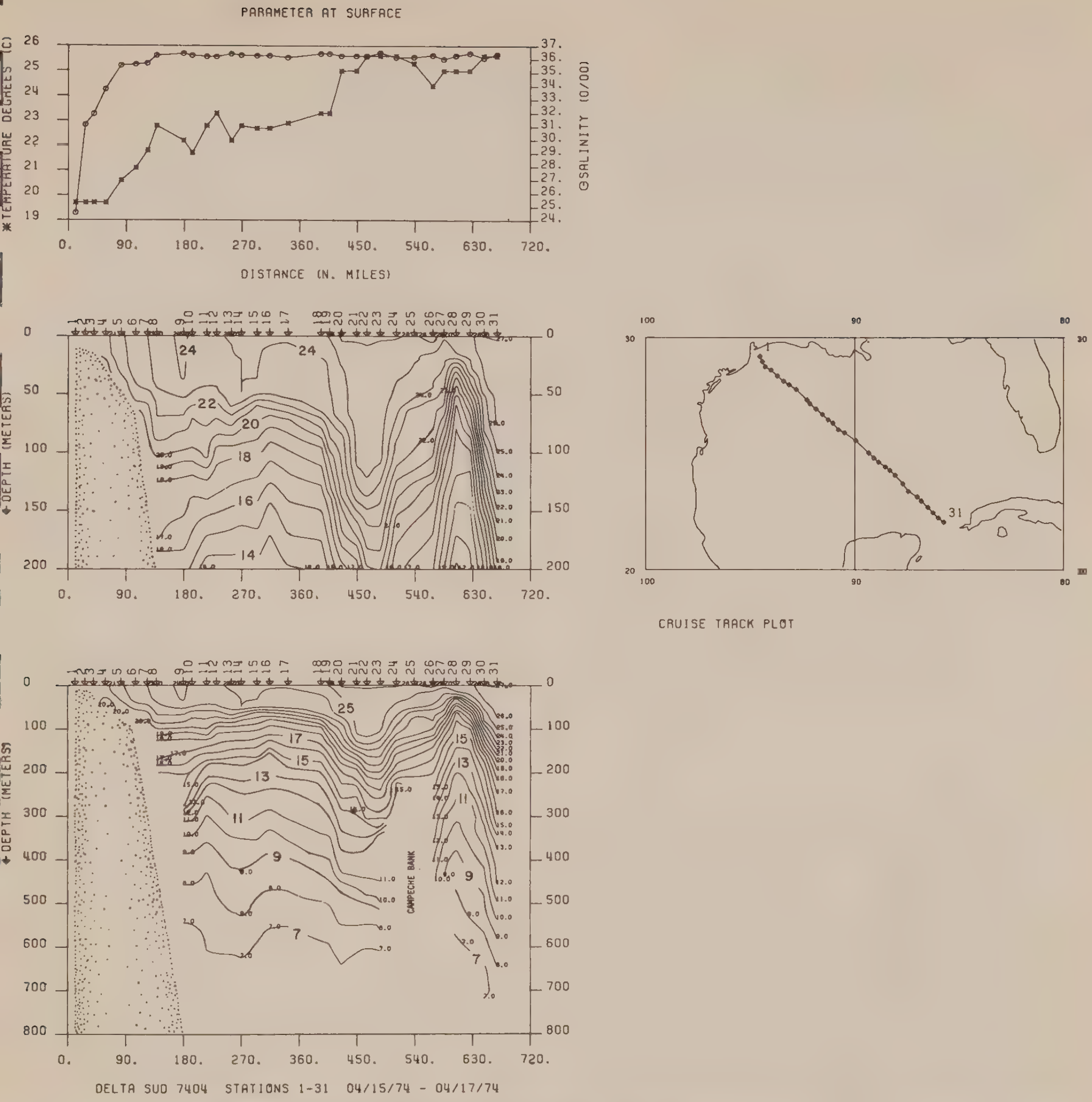


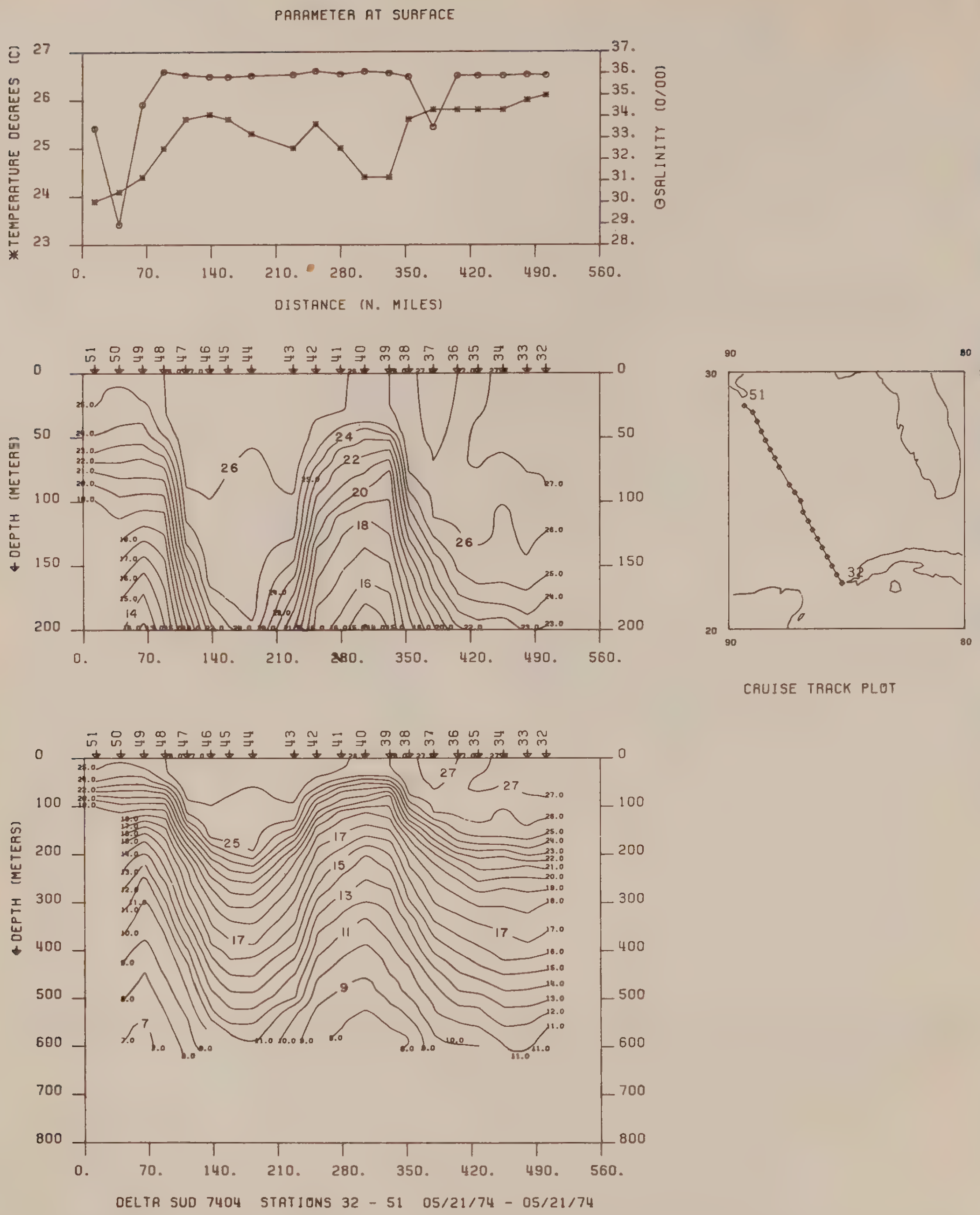
ppendix Figure 1.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—8-9 March 1974.



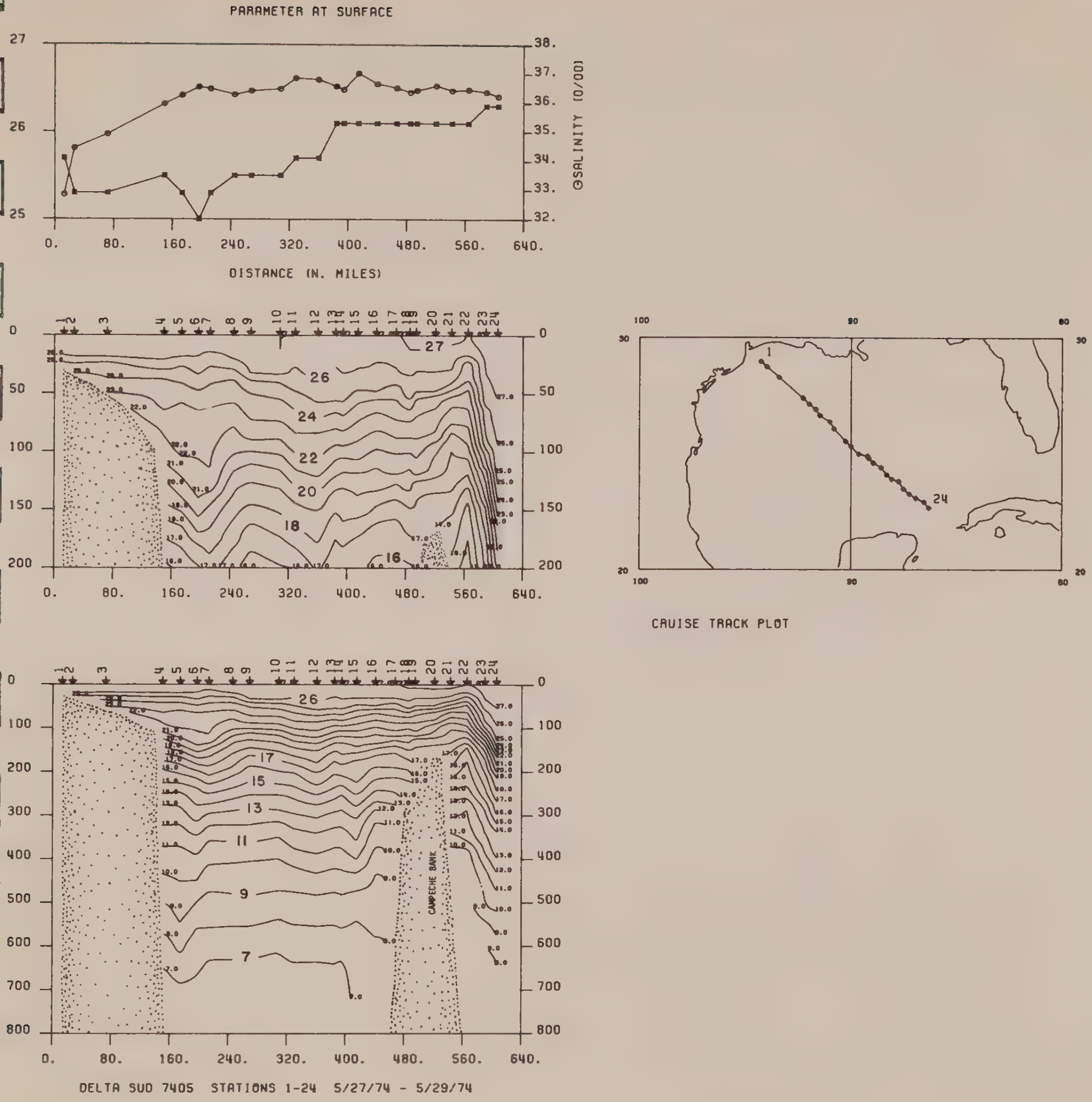
Appendix Figure 2.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution temperature (°C) in the upper 200 and 800 m. *Delta Norte*—21-23 March 1974.



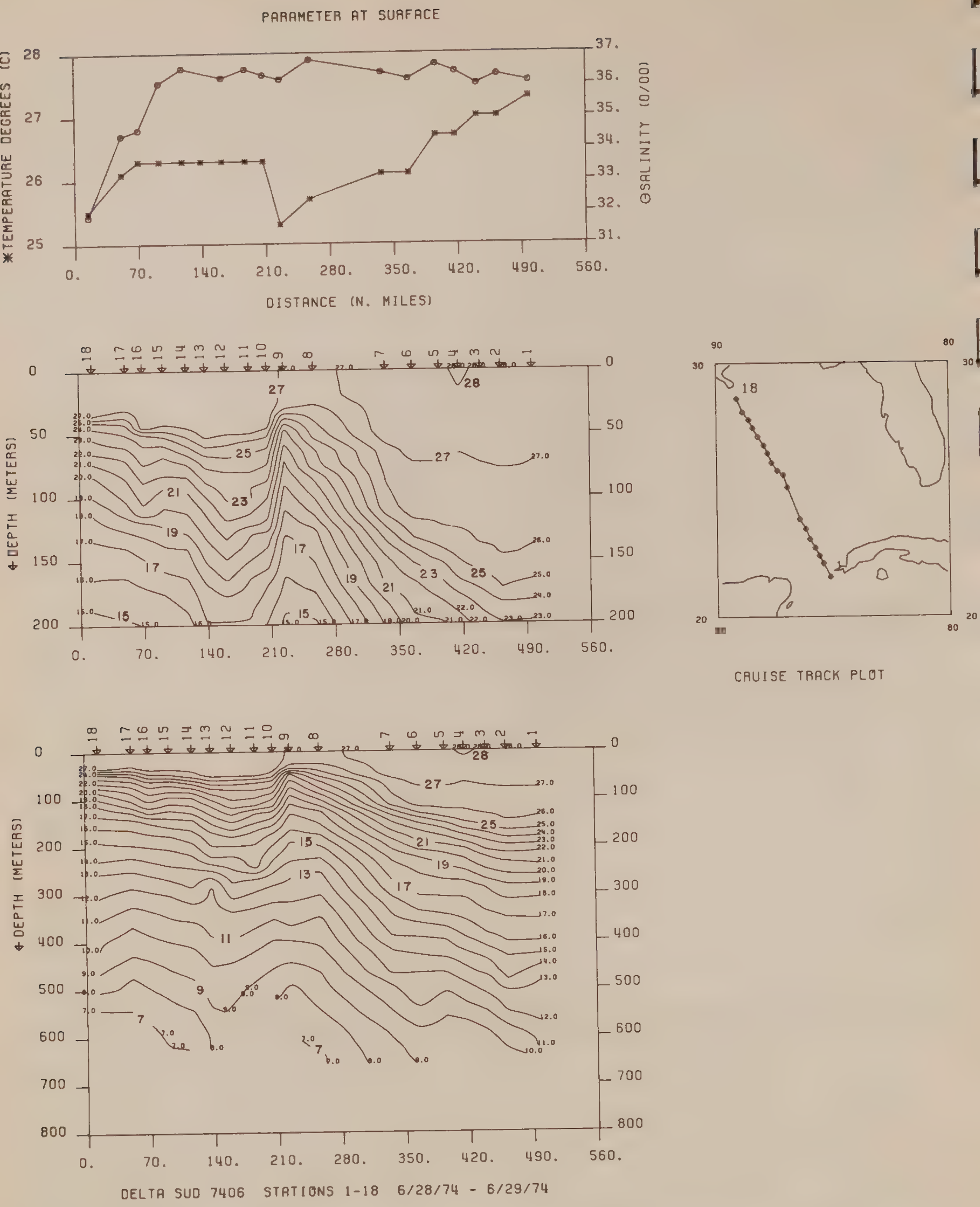
ppendix Figure 3.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—15-17 April 1974.



Appendix Figure 4.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distributio of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—21 May 1974.



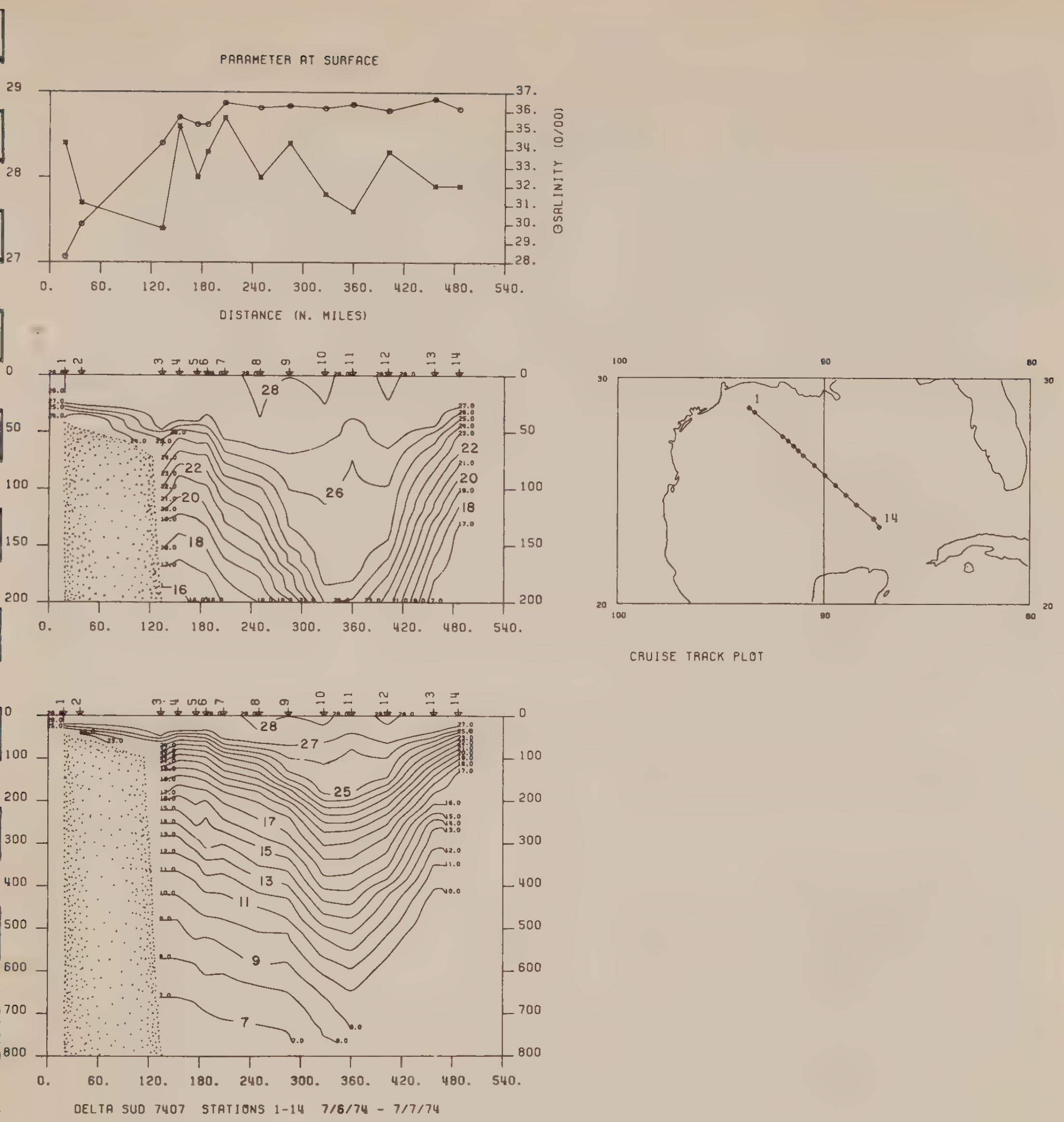
pendix Figure 5.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—27-29 May 1974.


PARAMETER AT SURFACE

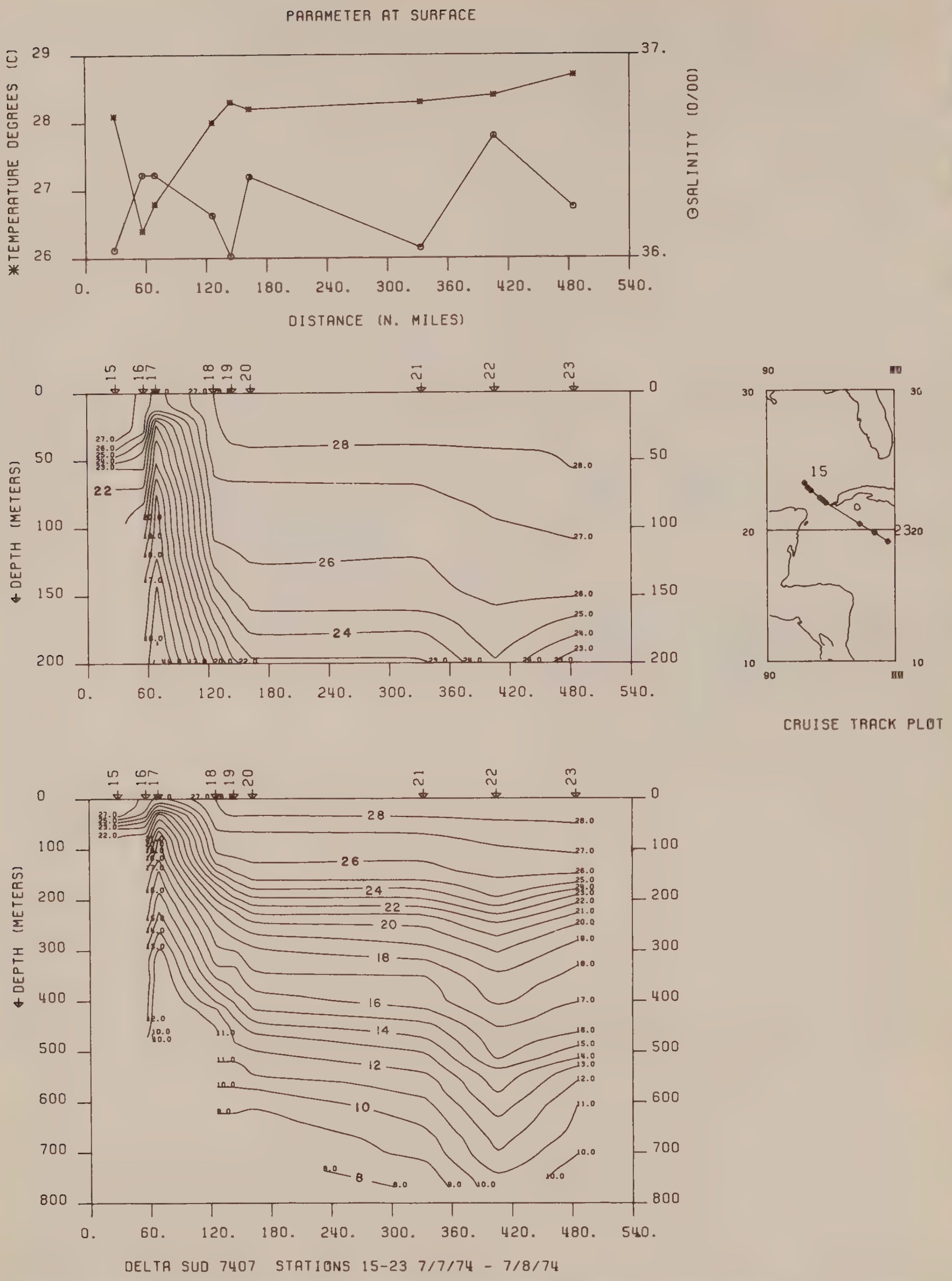
CRUISE TRACK PLOT

DELTA SUD 7406 STATIONS 1-18 6/28/74 - 6/29/74

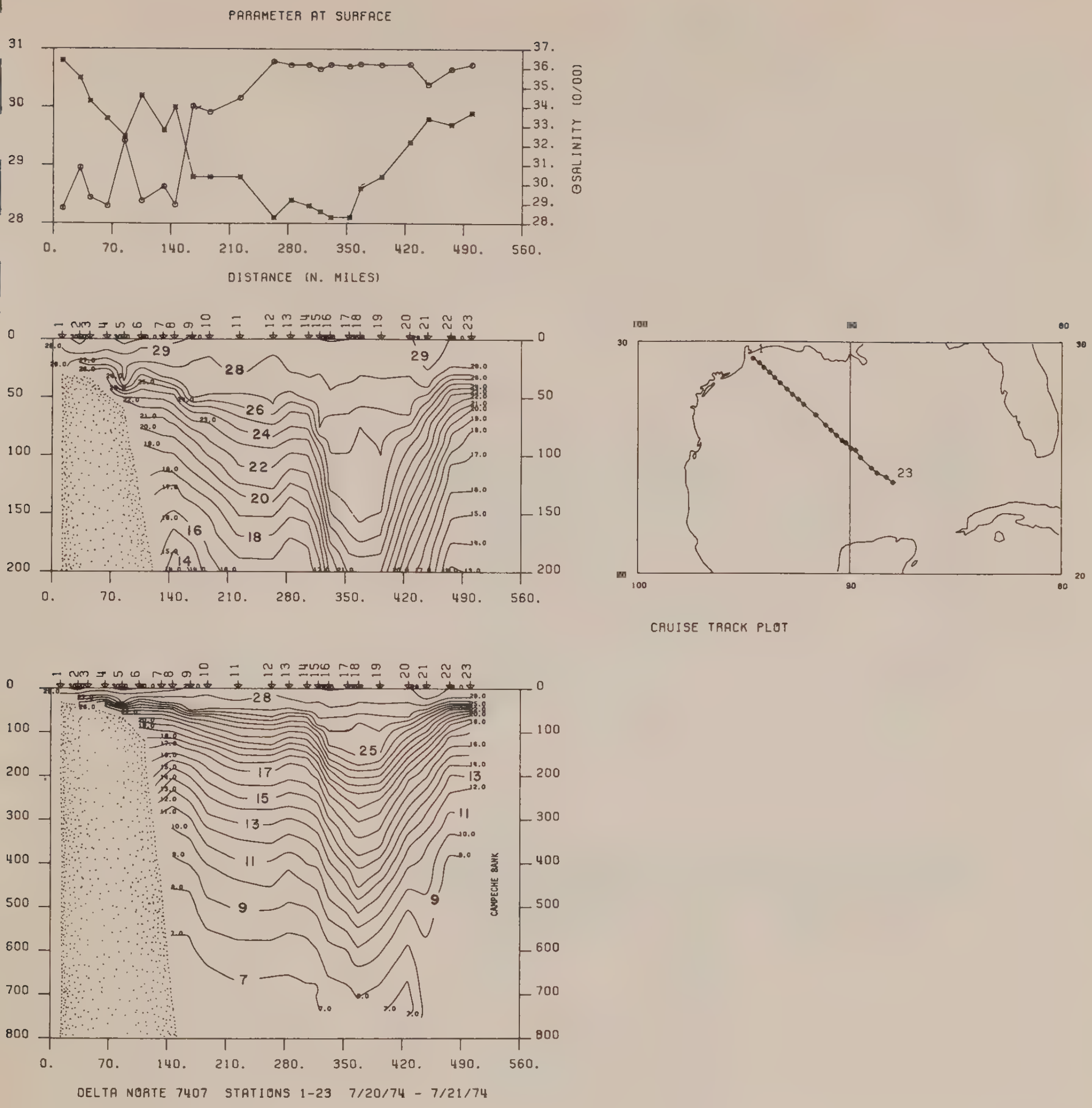
Appendix Figure 6.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—28-29 June 1974.



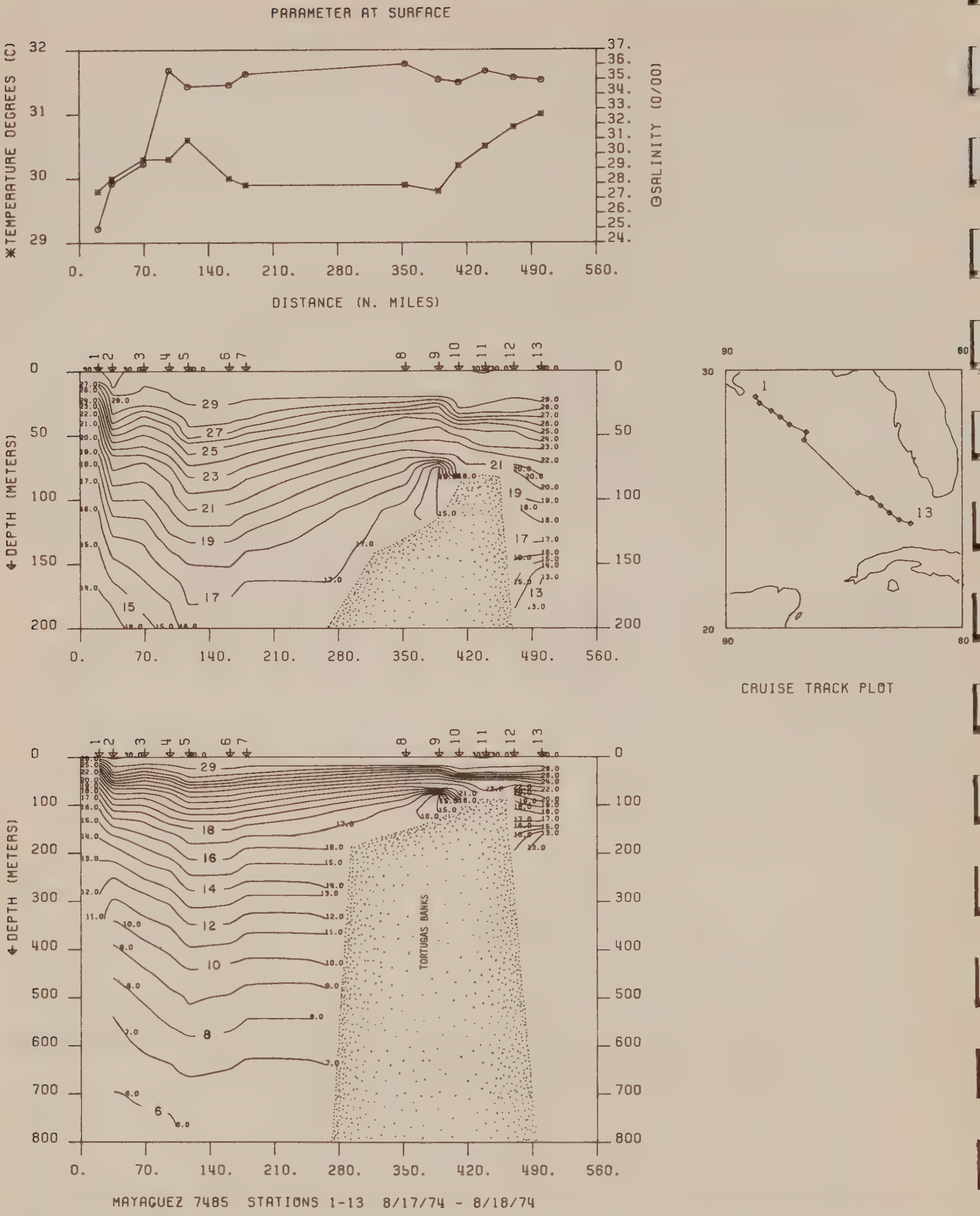
pendix Figure 7.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—6-7 July 1974.



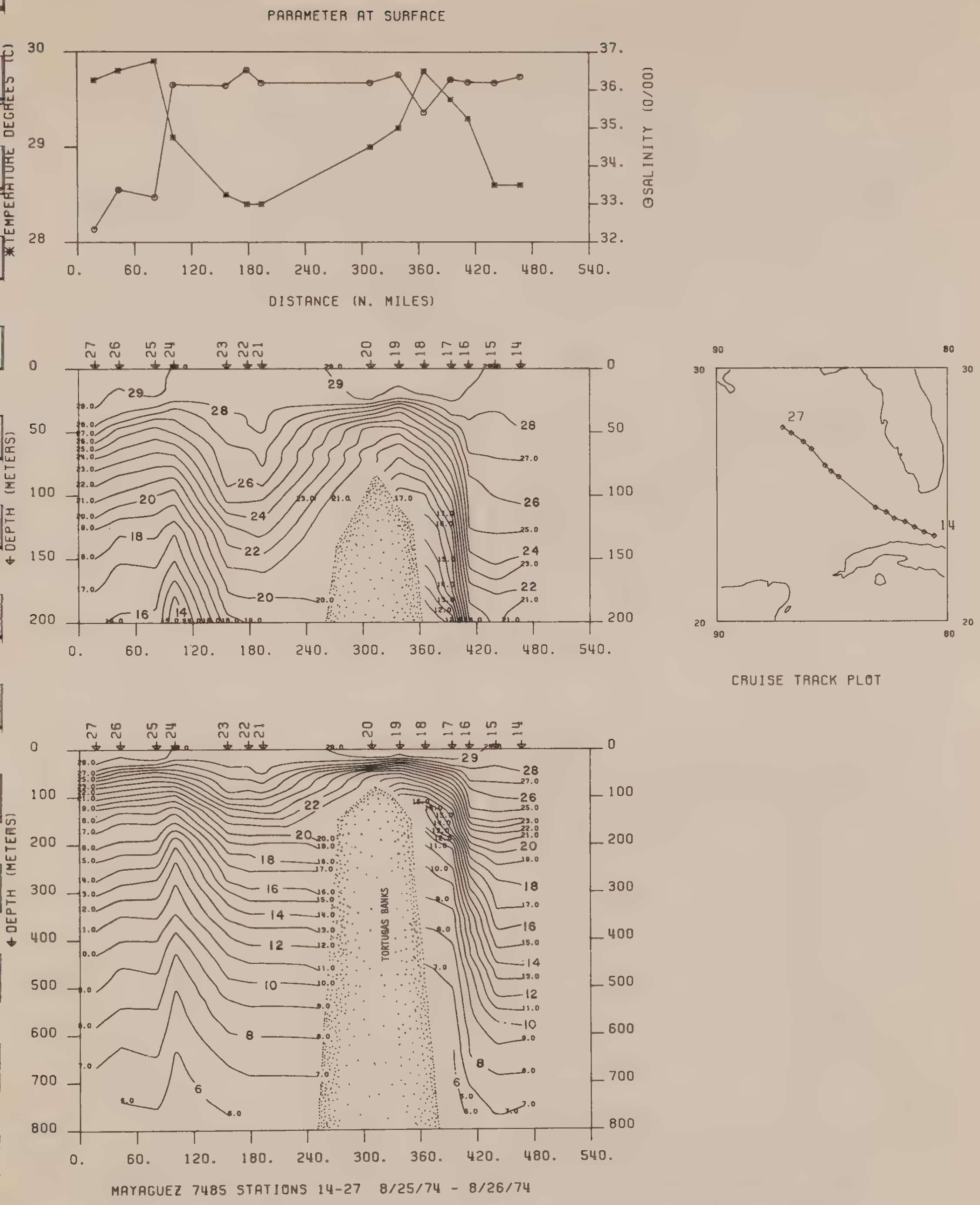
Appendix Figure 8.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—7-8 July 1974.



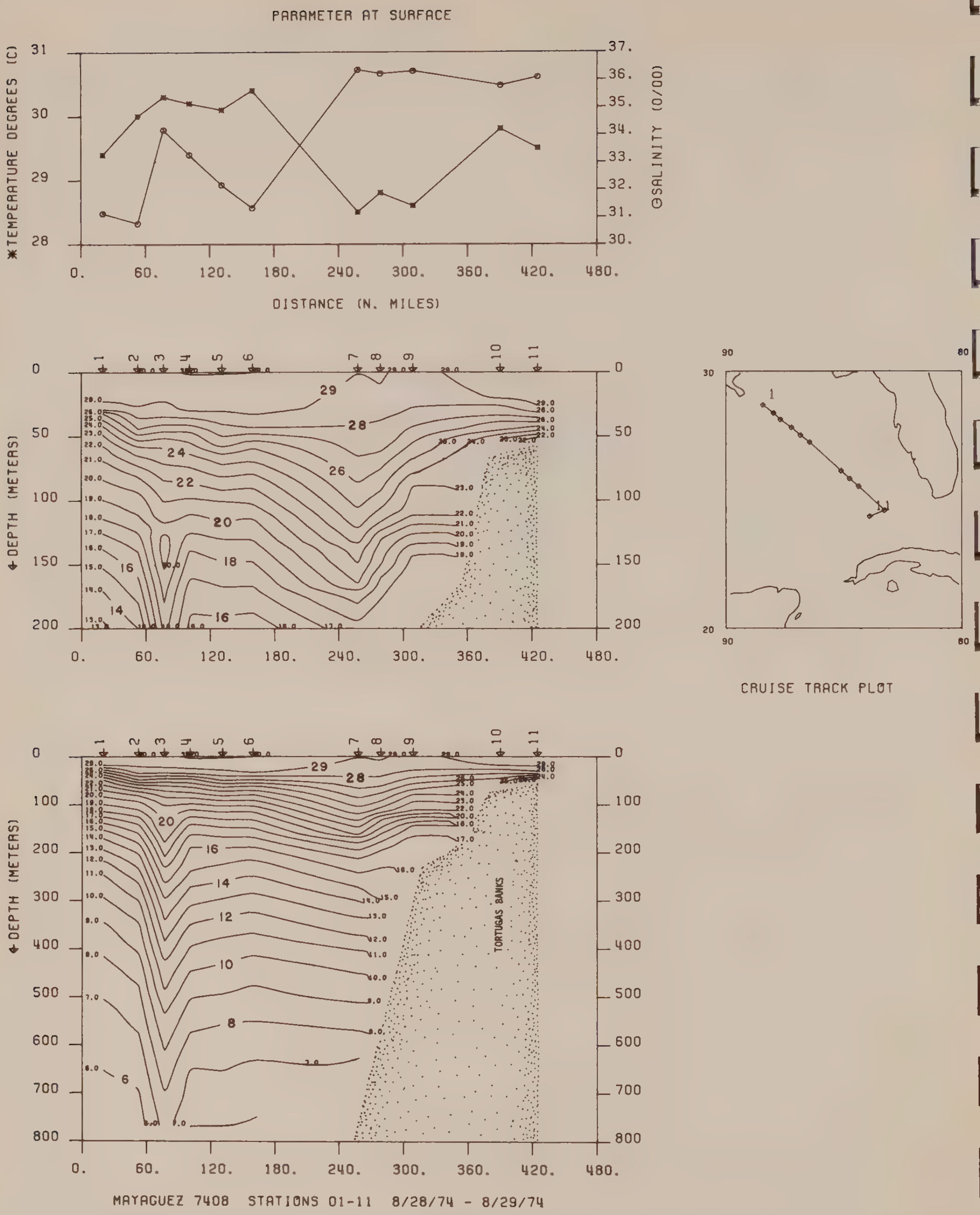
ppendix Figure 9.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Norte*—20-21 July 1974.



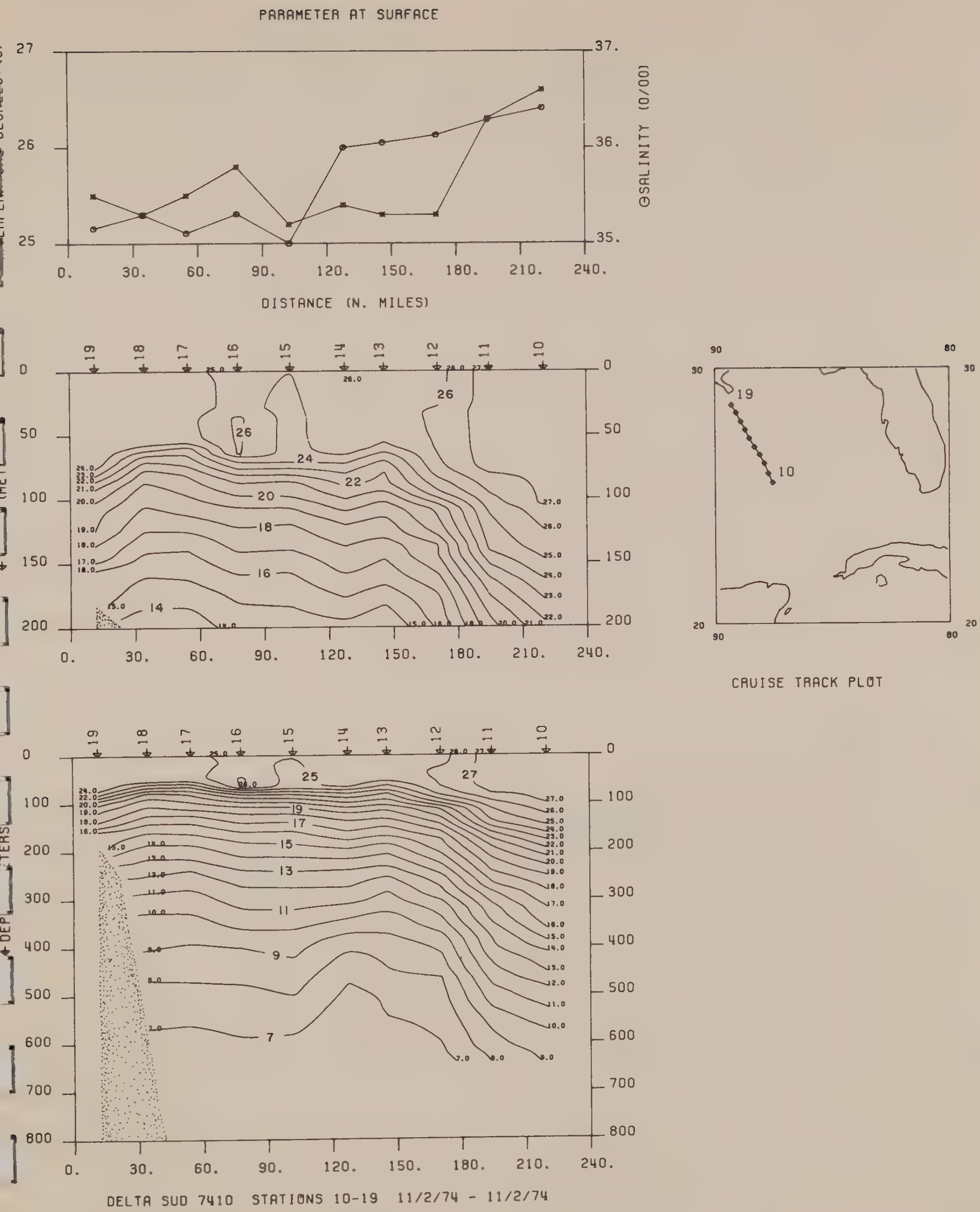
Appendix Figure 10.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distributi of temperature (°C) in the upper 200 and 800 m. *Mayaguez*—17-18 August 1974.



Appendix Figure 11.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Mayaguez*—25-26 August 1974.



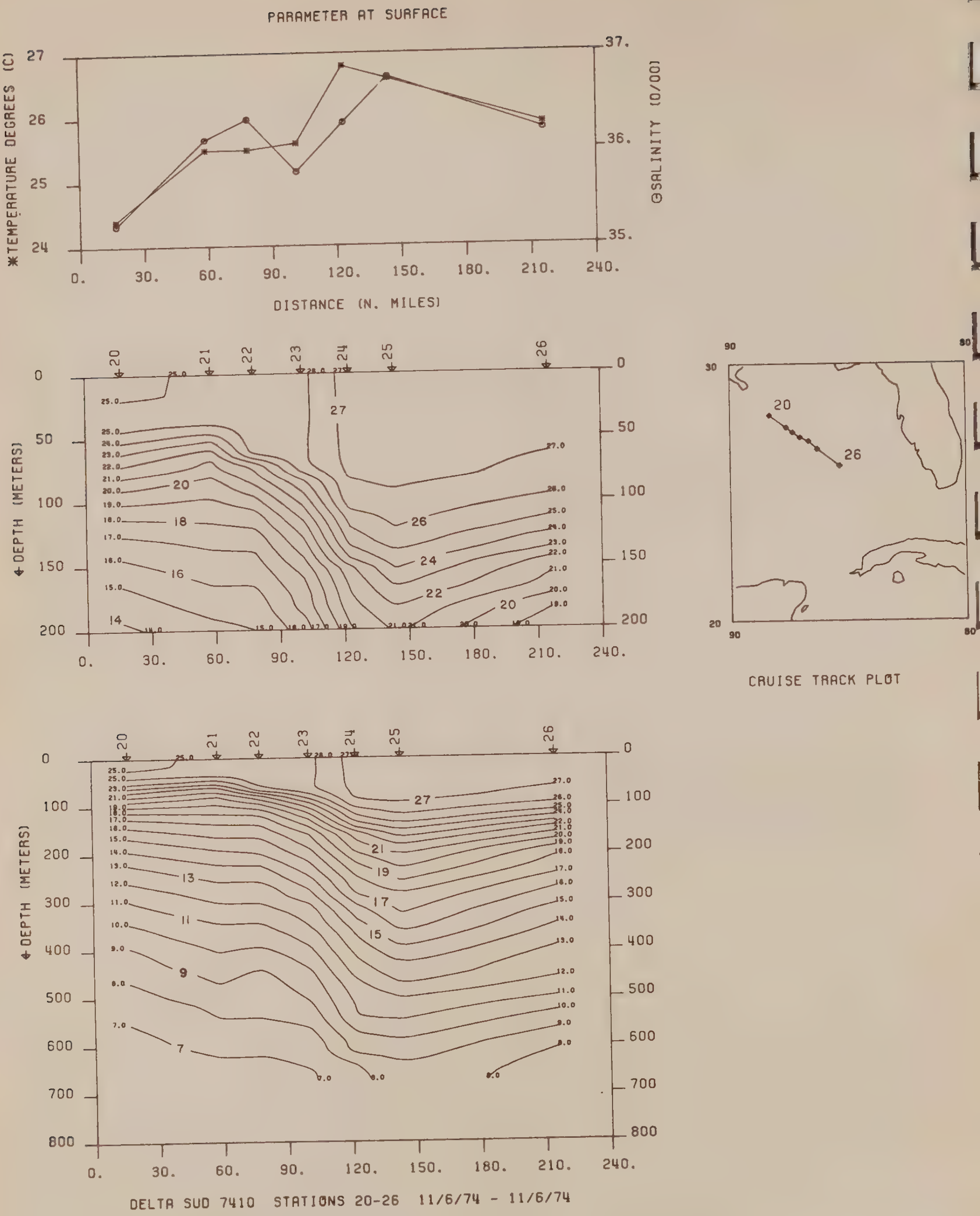
Appendix Figure 12.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distributio of temperature (°C) in the upper 200 and 800 m. *Mayaguez*—28-29 August 1974.


PARAMETER AT SURFACE

CRUISE TRACK PLOT

DELTA SUD 7410 STATIONS 10-19 11/2/74 - 11/2/74

pendix Figure 13.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—2 November 1974.



Appendix Figure 14.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribu of temperature (°C) in the upper 200 and 800 m. *Delta Sud*—6 November 1974.

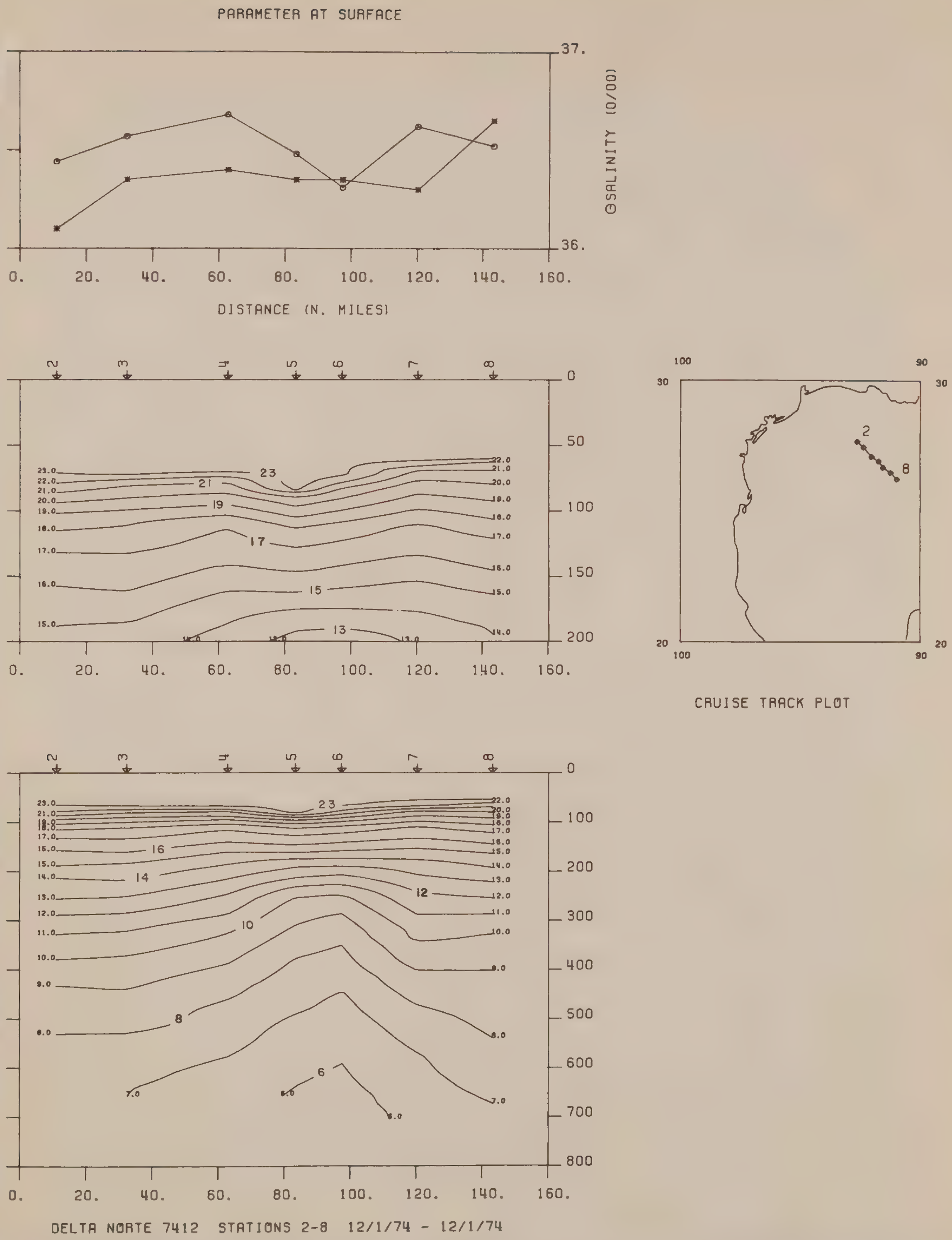
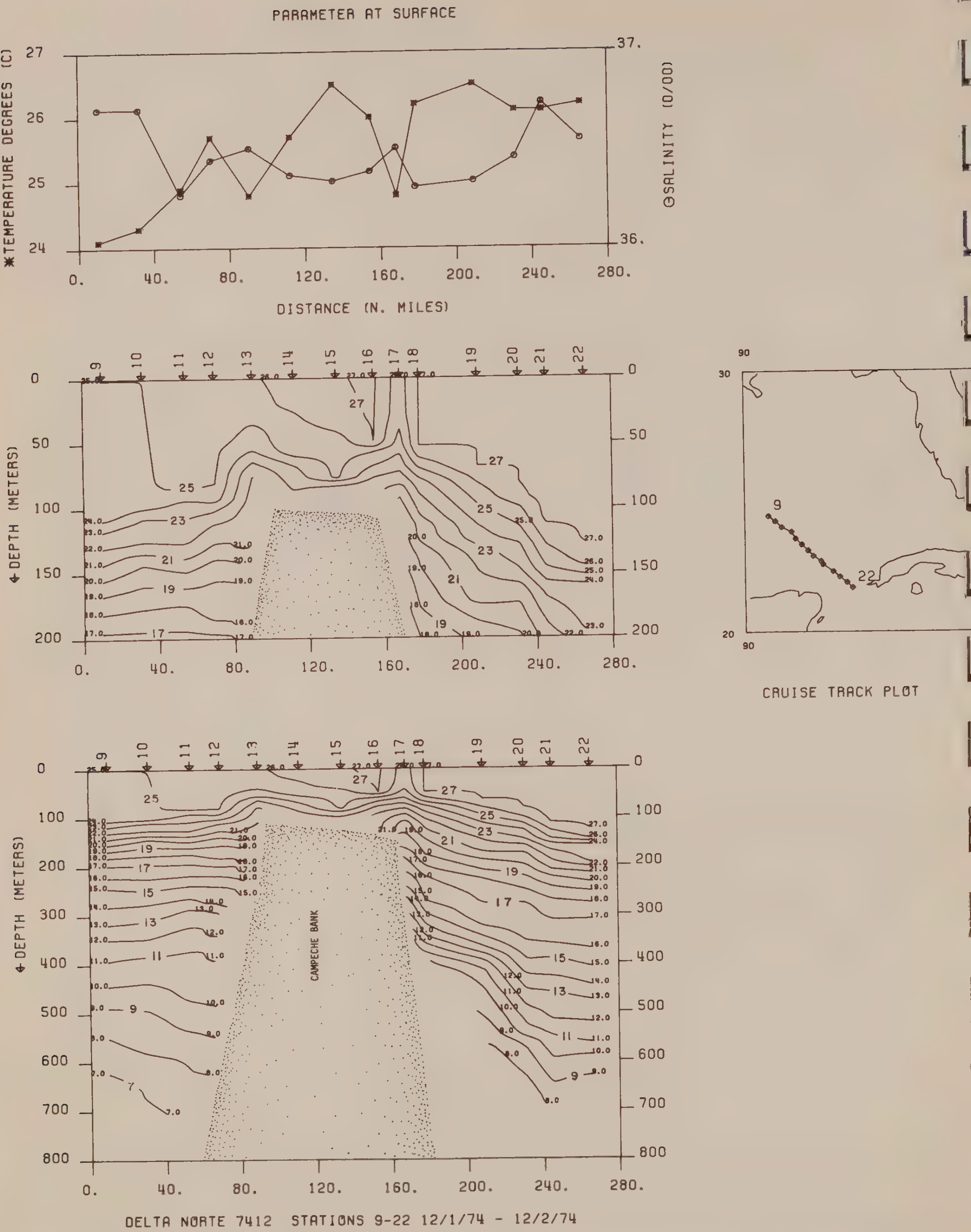
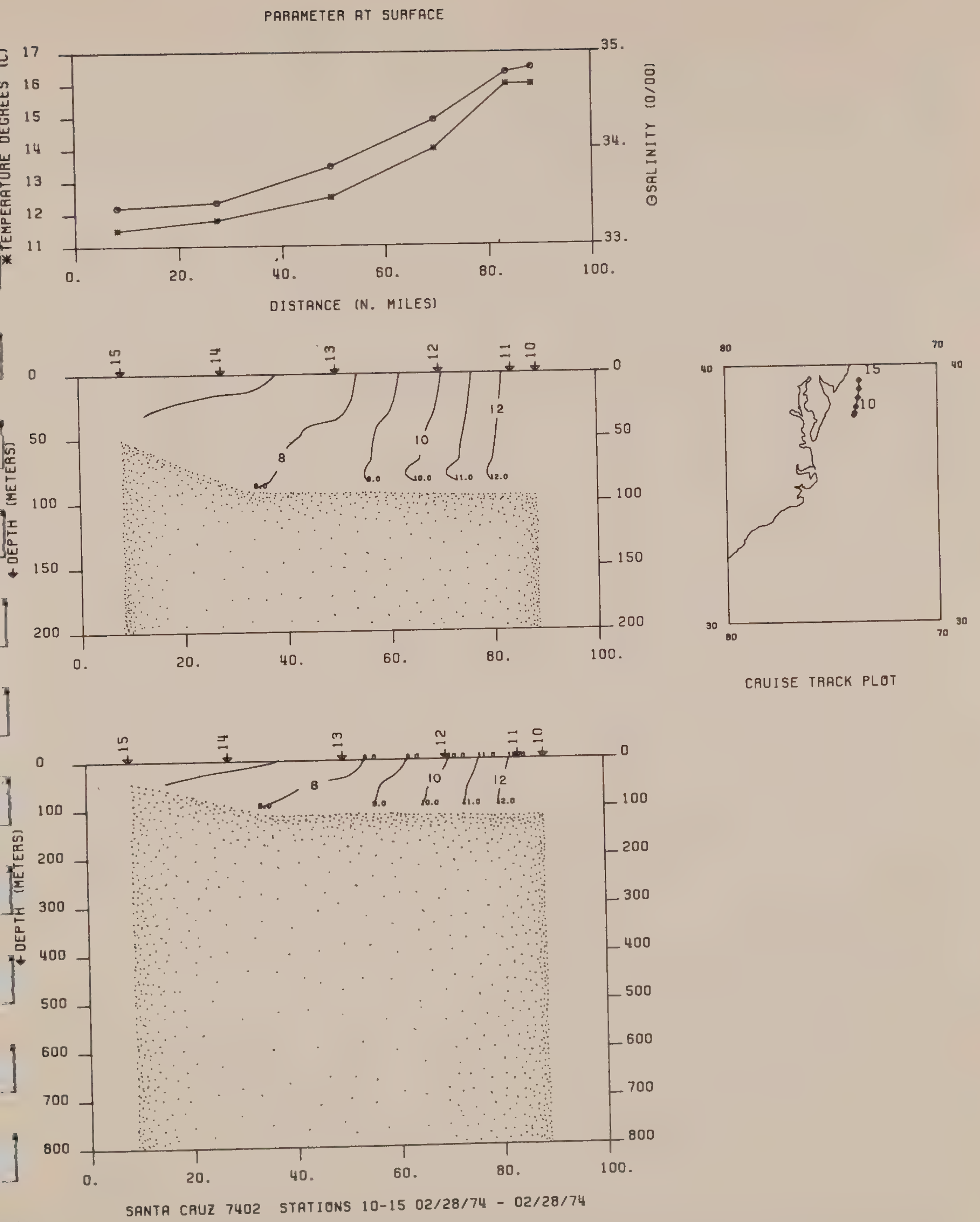


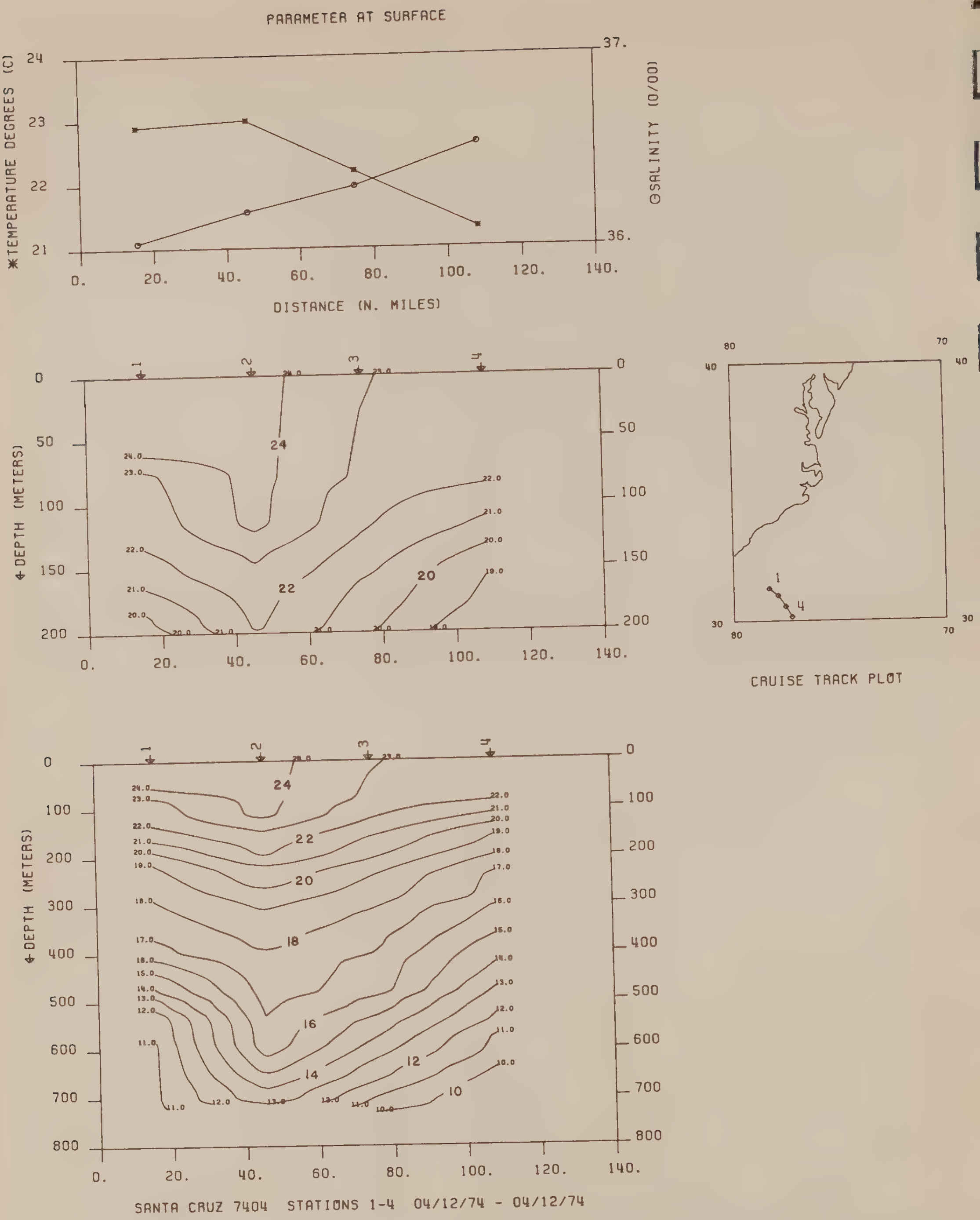
Figure 15.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 8 00 m. *Delta Norte*—1 December 1974.



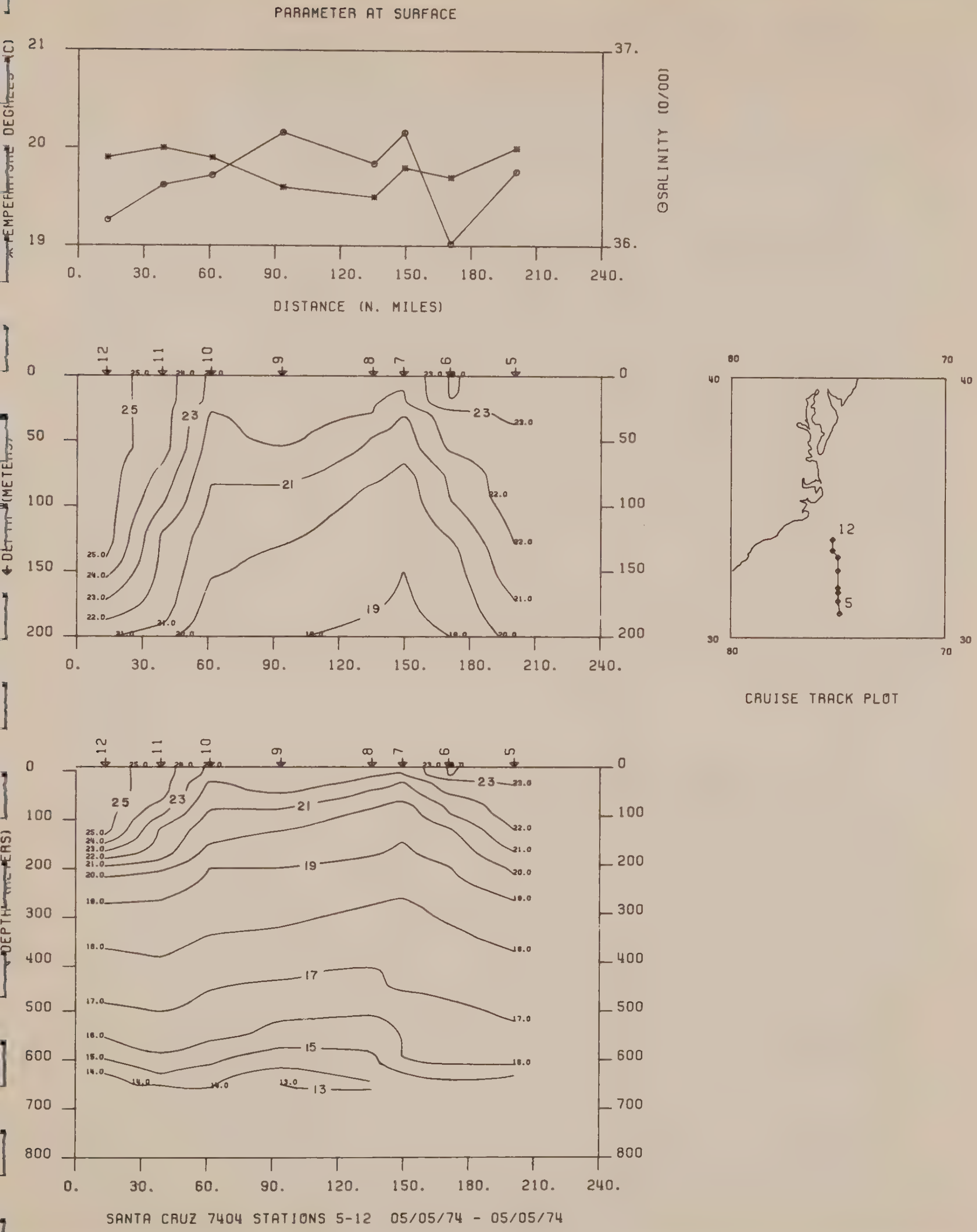
Appendix Figure 16.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distribution of t ture (°C) in the upper 200 and 800 m. *Delta Norte*—1-2 December 1974.



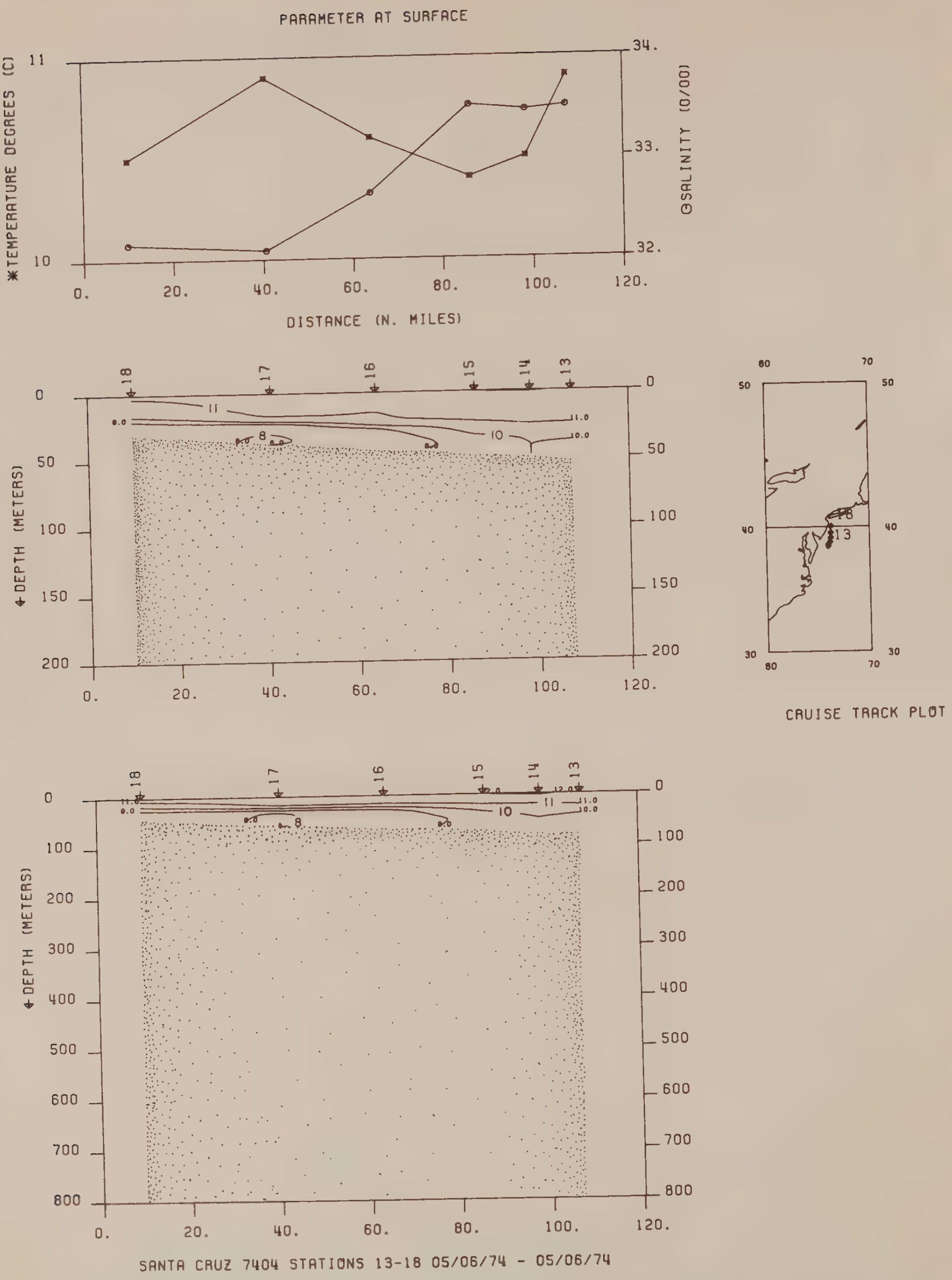
Appendix Figure 17.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—28 February 1974.



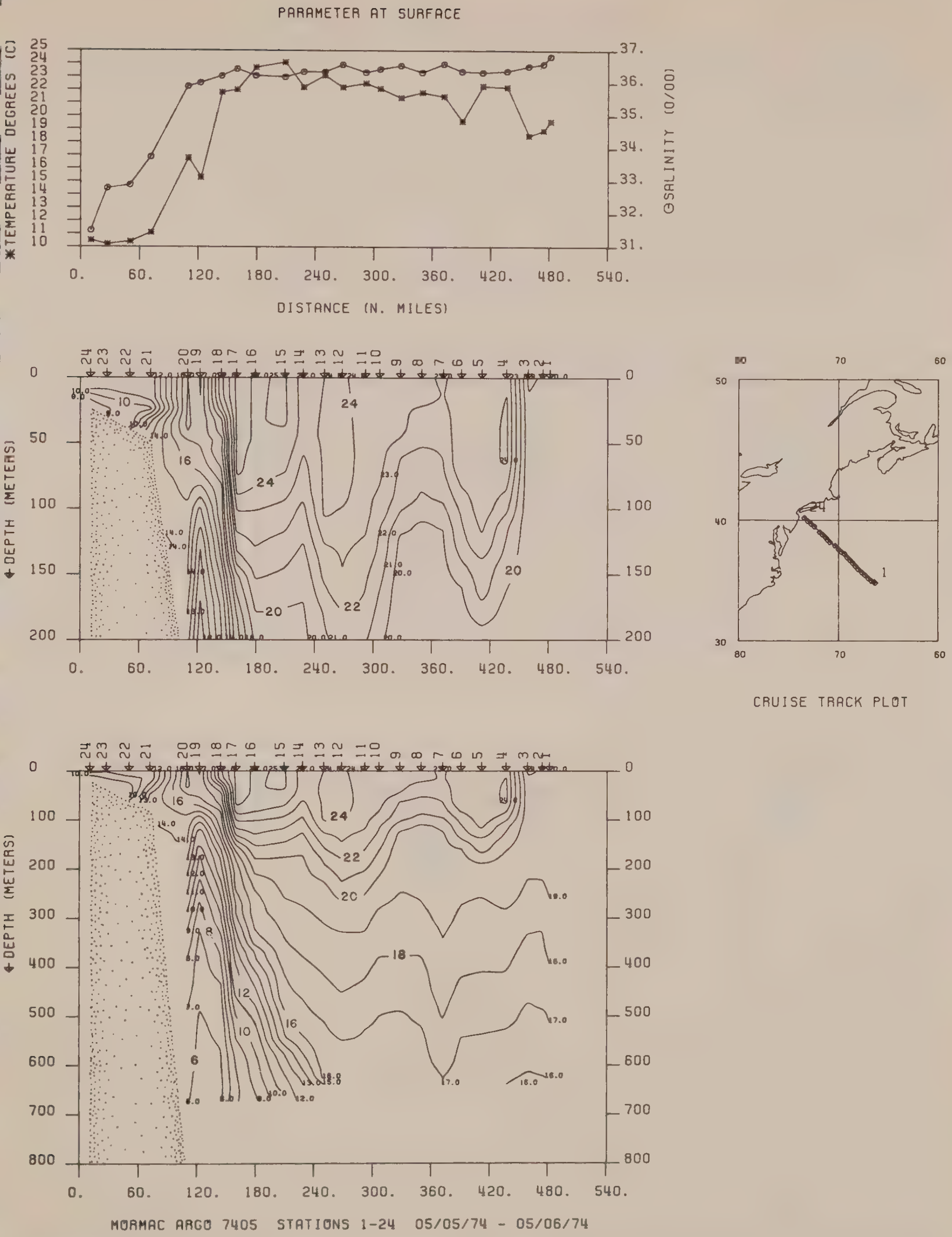
Appendix Figure 18.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distrib tion of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—12 April 1974.



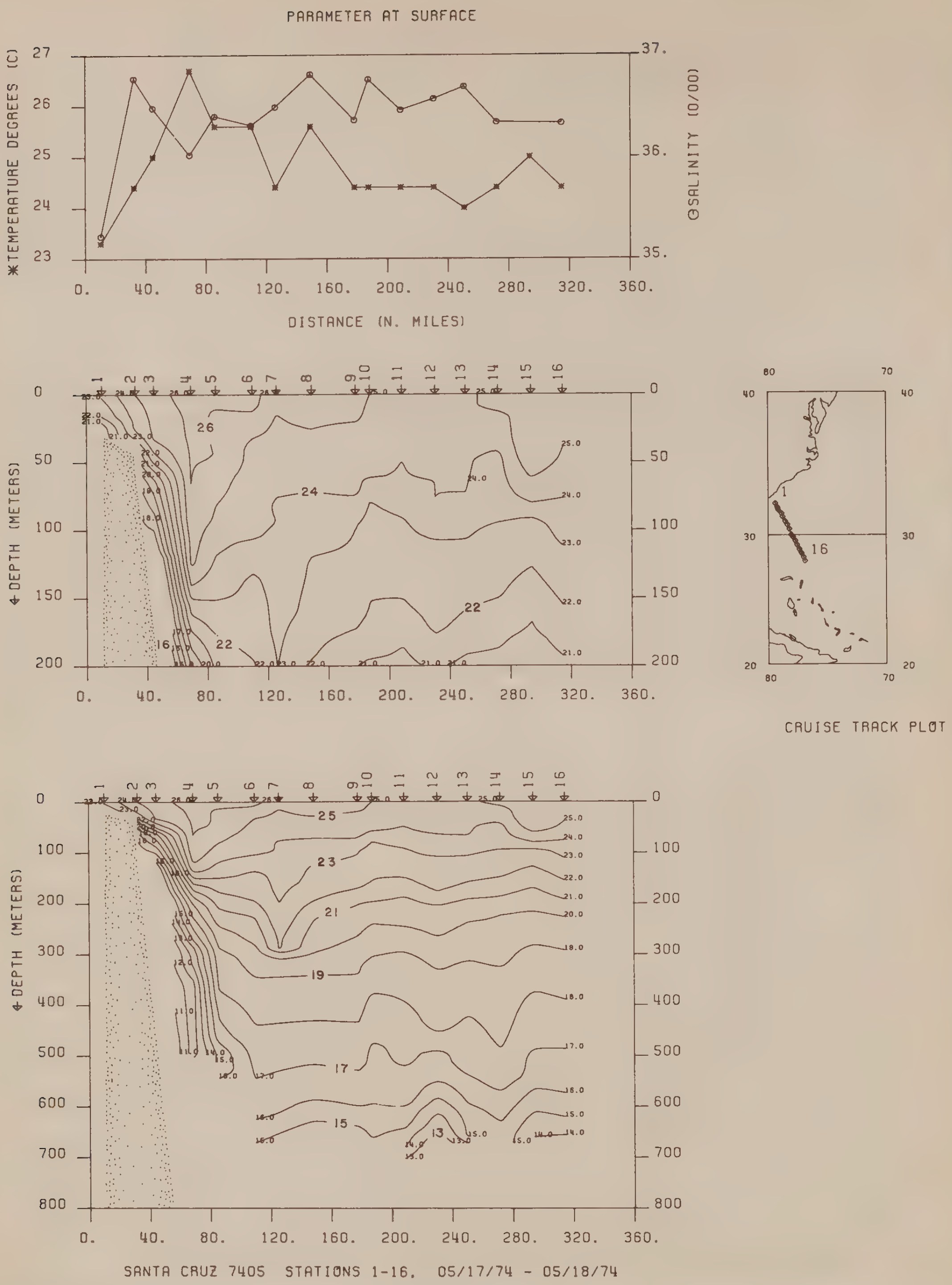
ppendix Figure 19.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—5 May 1974.



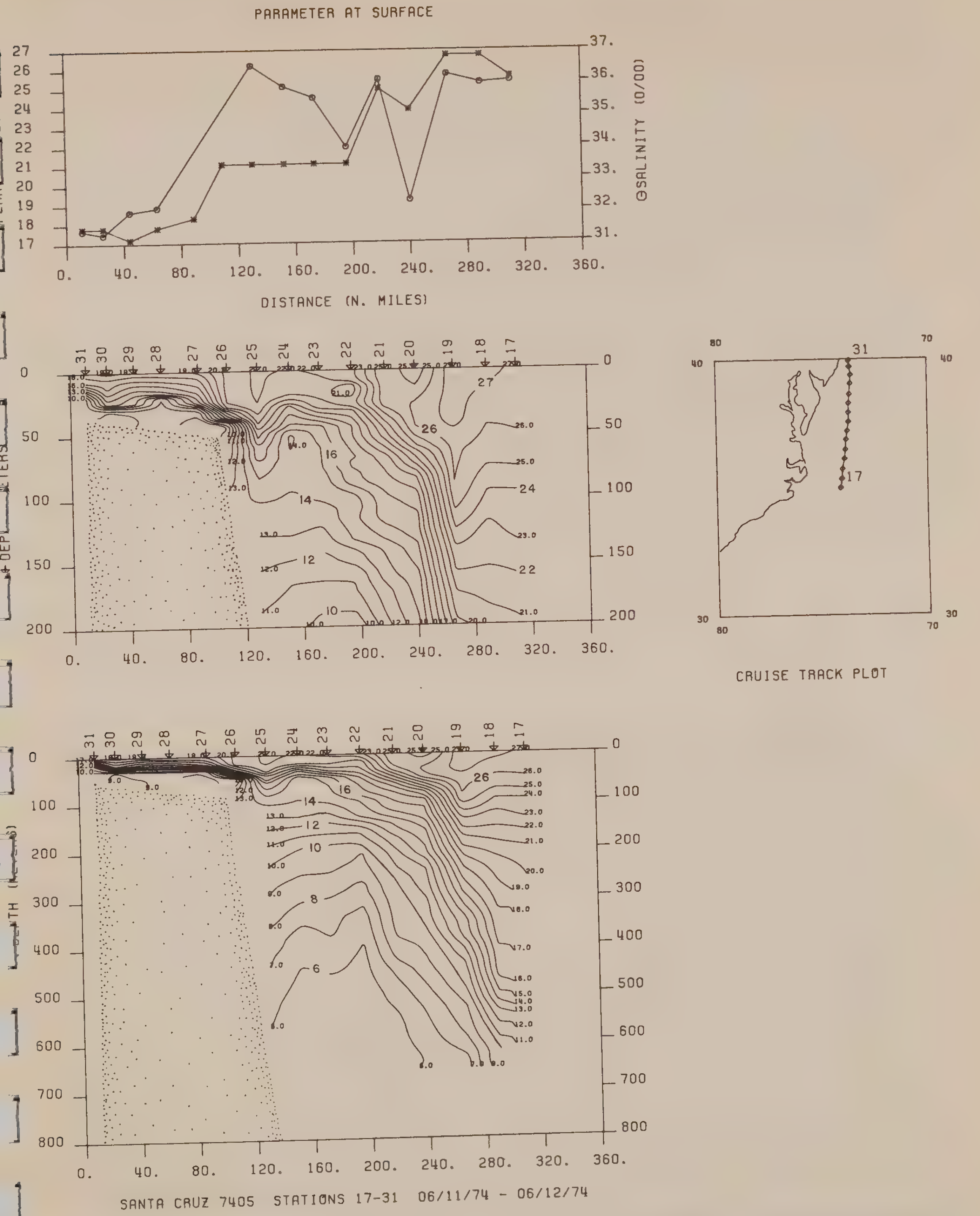
Appendix Figure 20.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—6 May 1974.



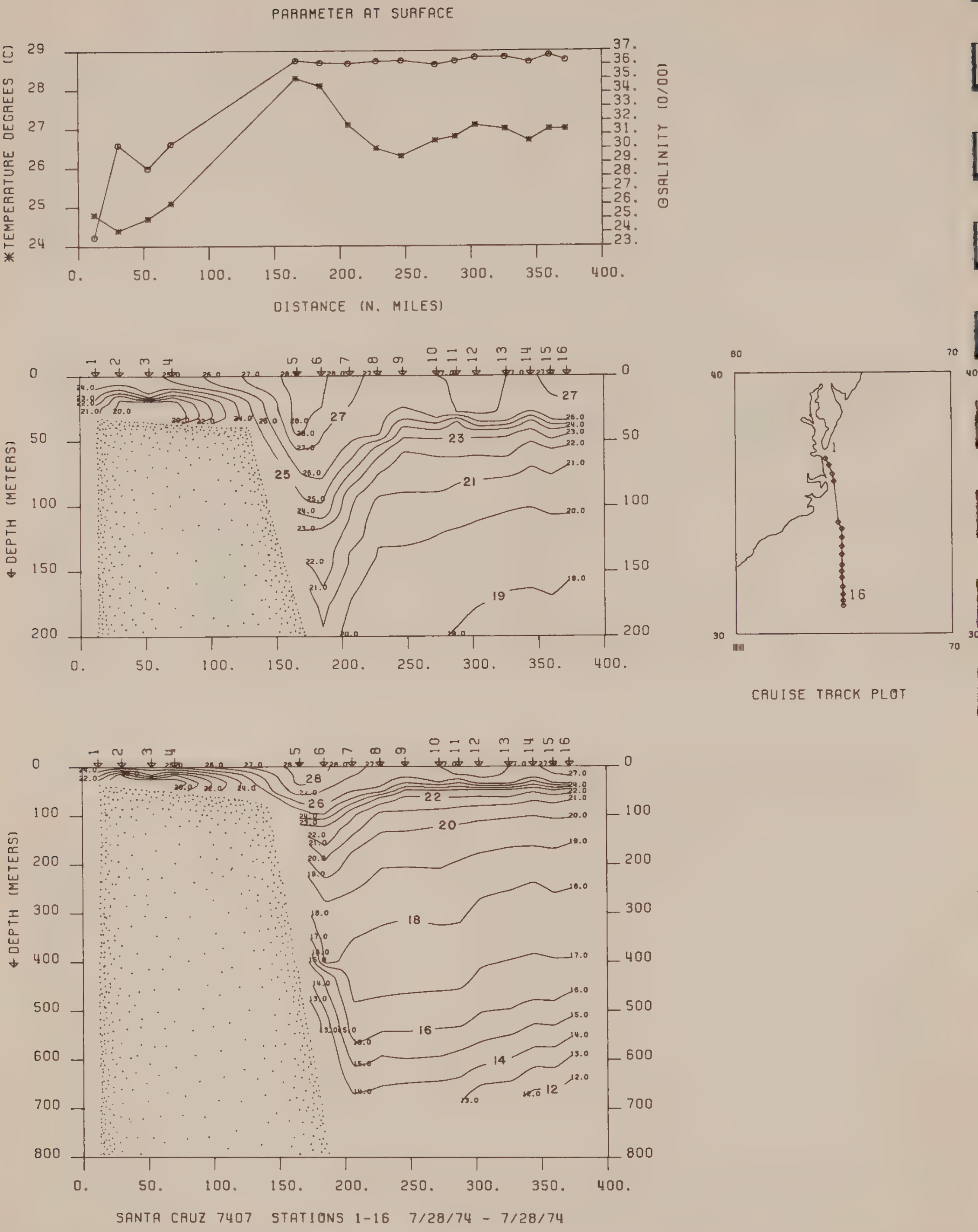
Appendix Figure 21.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Mormac Argo*—5-6 May 1974.



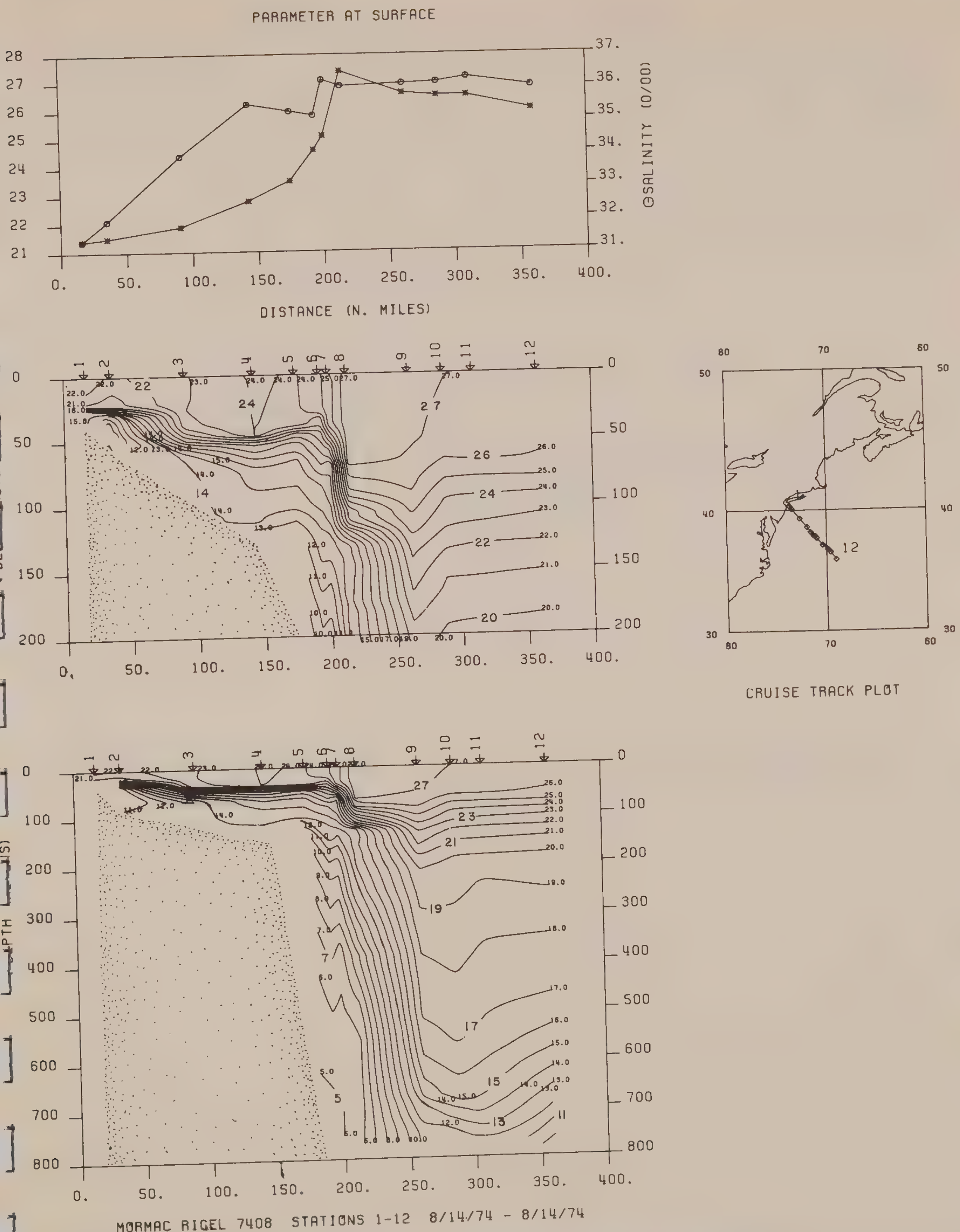
Appendix Figure 22.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—17-18 May 1974.



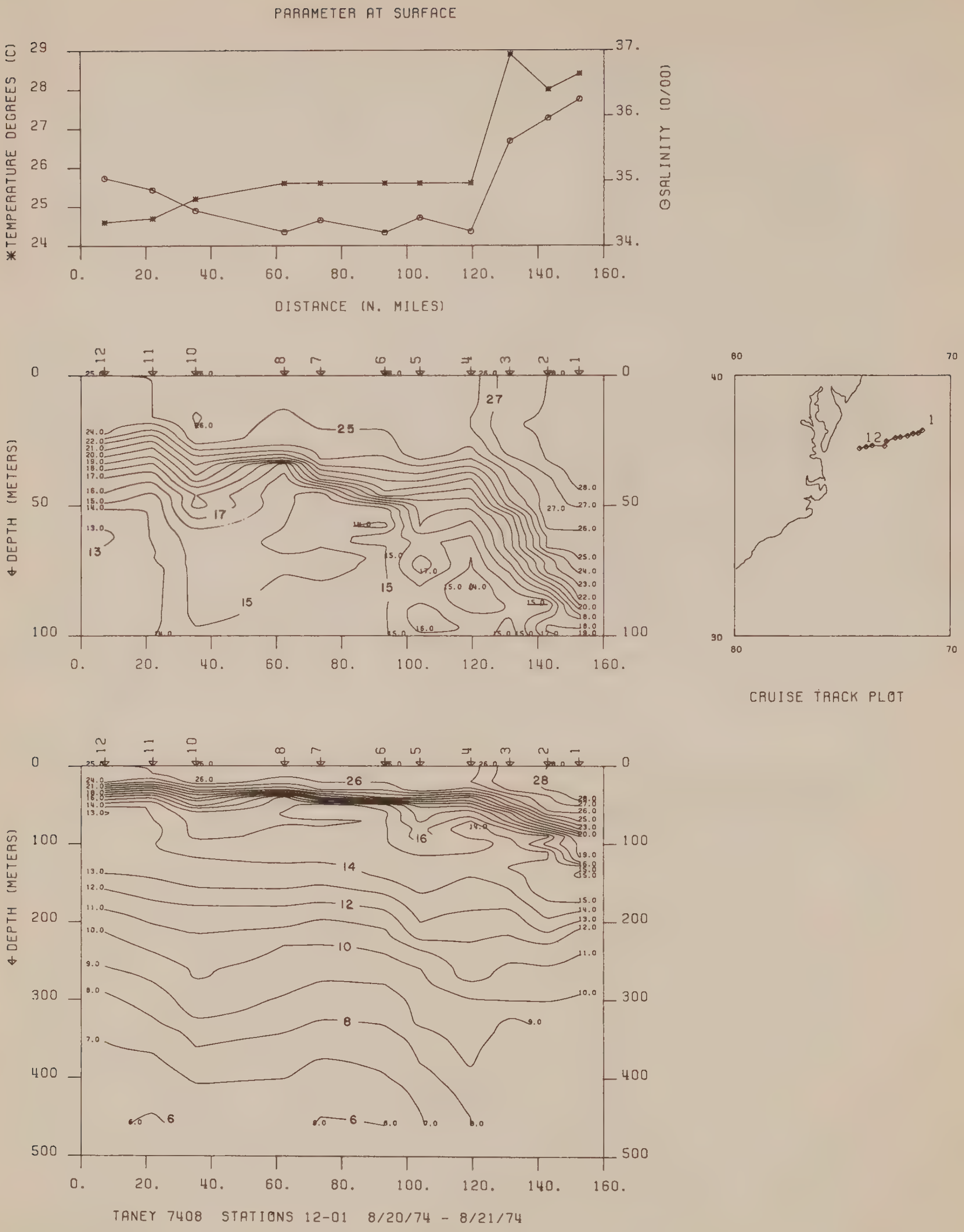
Appendix Figure 23.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—11-12 June 1974.



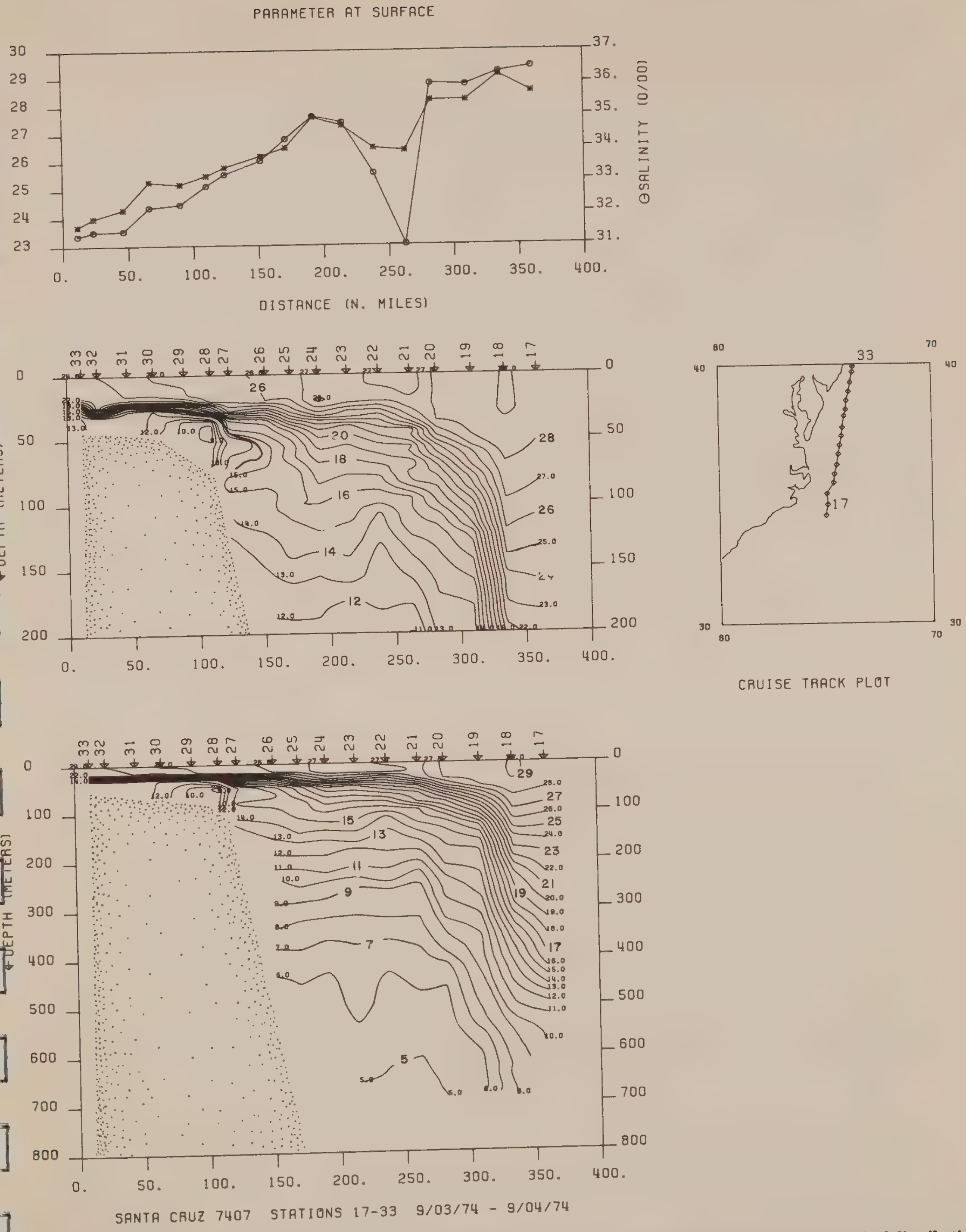
Appendix Figure 24.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/∘∘) and vertical distributio of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—28 July 1974.



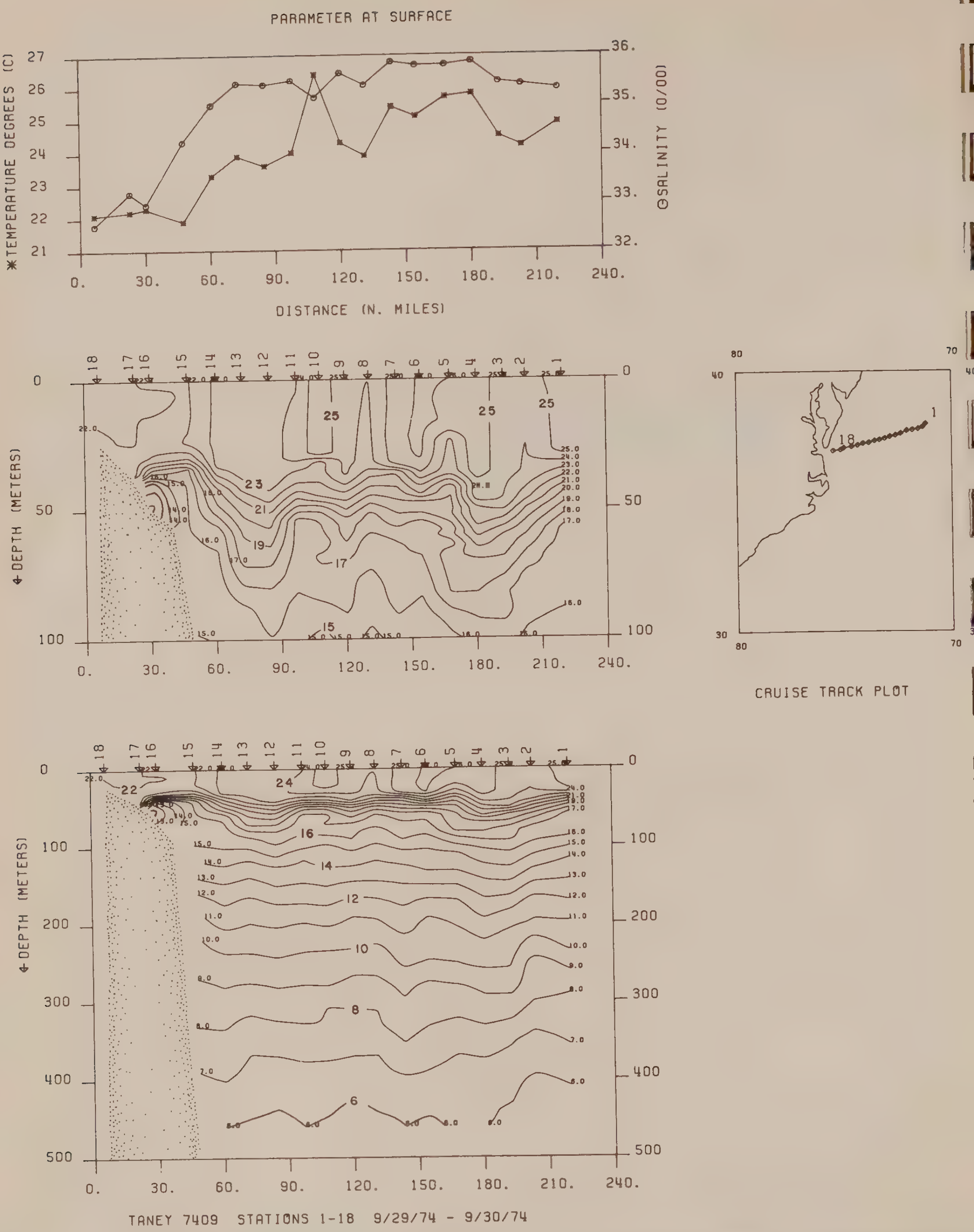
Appendix Figure 25.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Mormac Rigel*—14 August 1974.



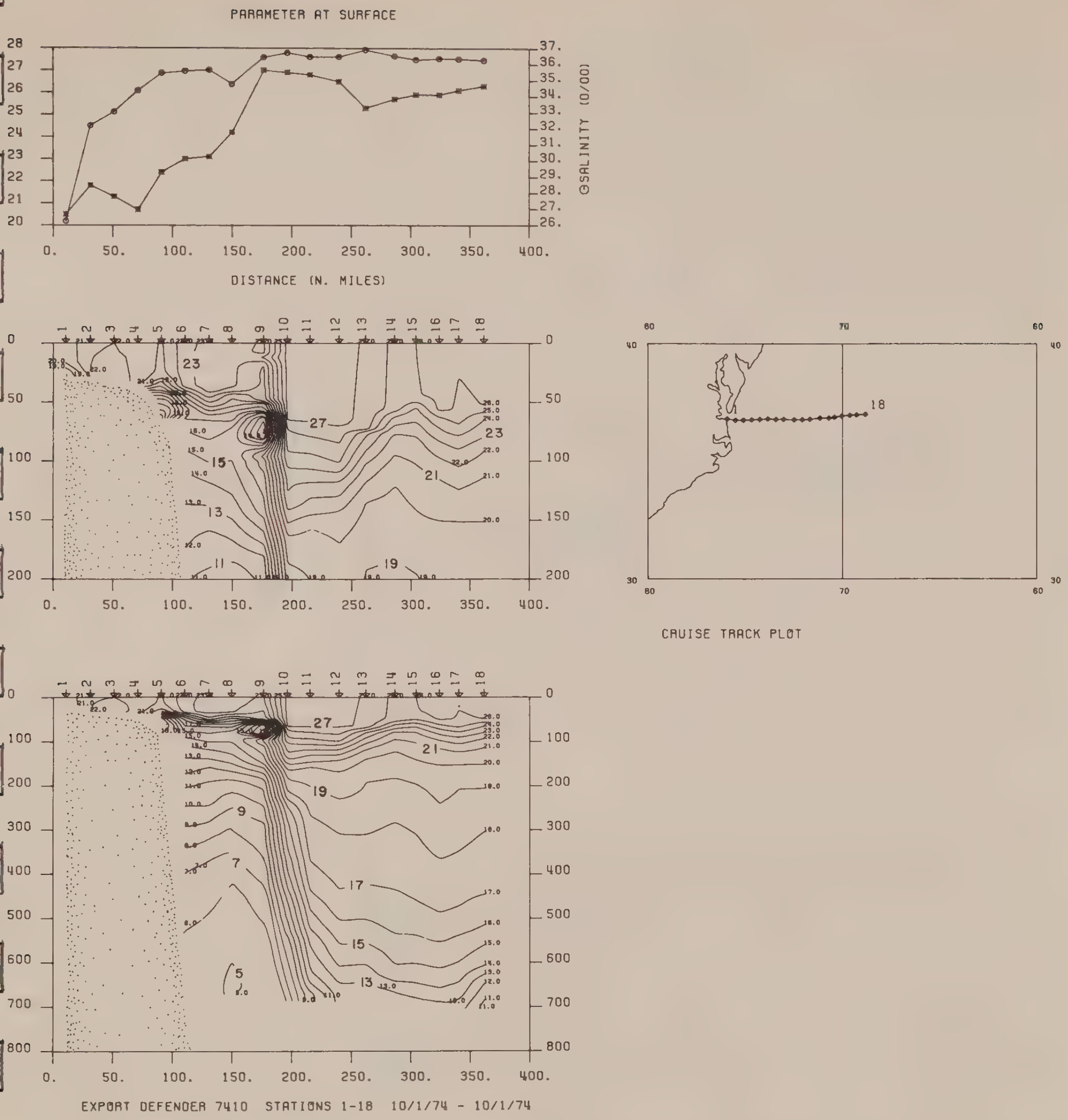
Appendix Figure 26.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distributi of temperature (°C) in the upper 200 and 800 m. USCGC *Taney*—20-21 August 1974.



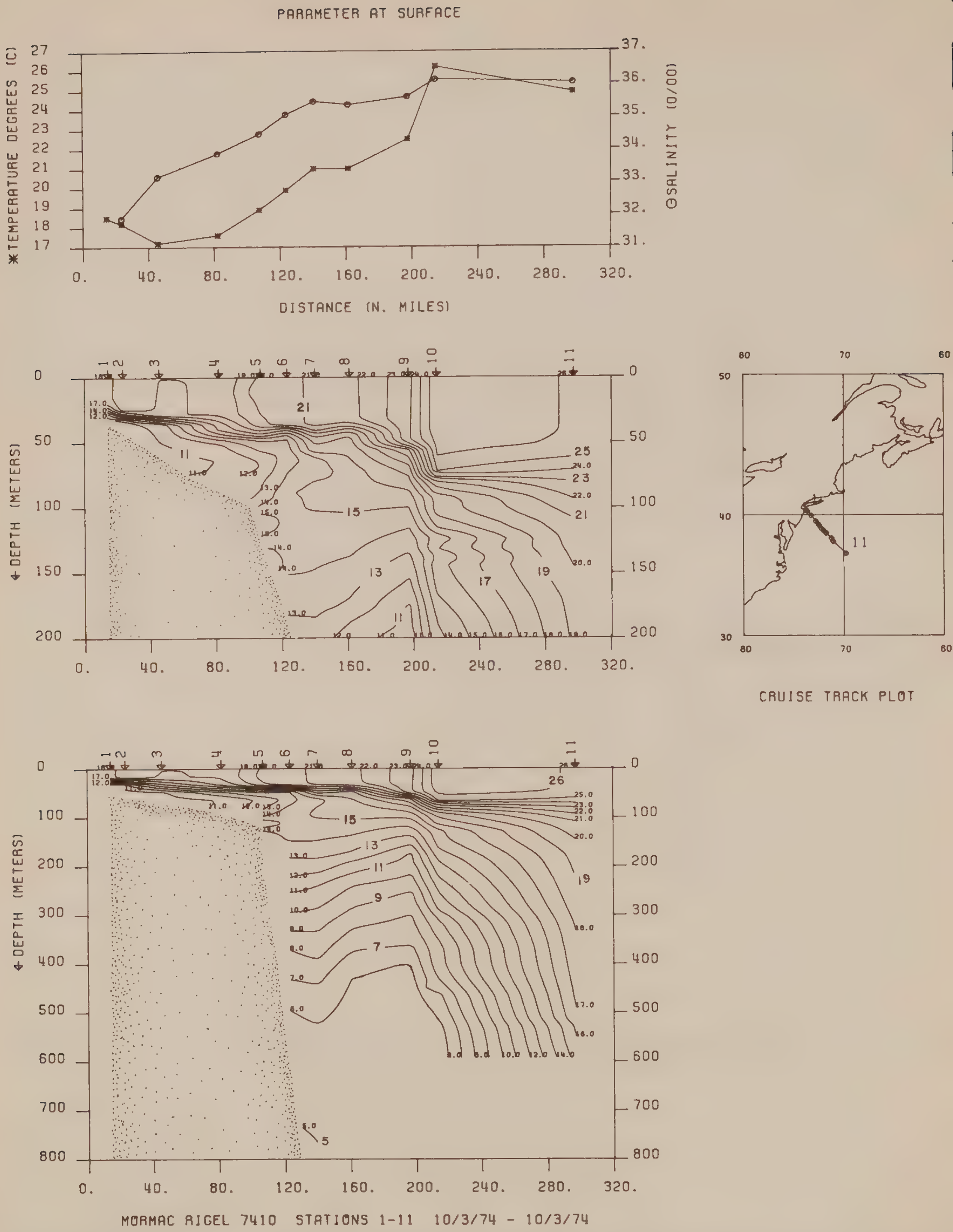
Appendix Figure 27.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—3-4 September 1974.



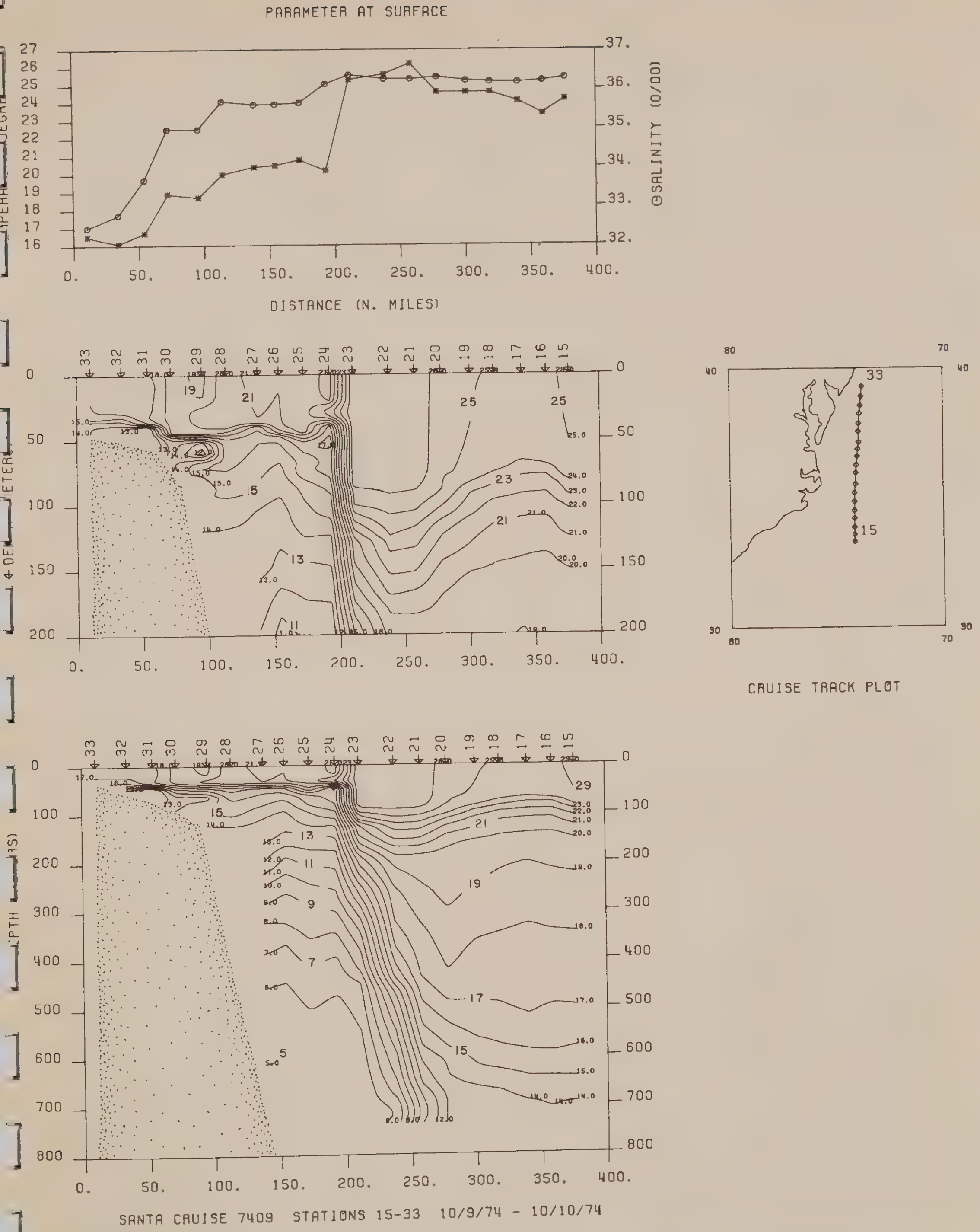
Appendix Figure 28.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribut of temperature (°C) in the upper 200 and 800 m. USCGC *Taney*—29-30 September 1974.



pendix Figure 29.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Export Defender*—1 October 1974.



Appendix Figure 30.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribut of temperature (°C) in the upper 200 and 800 m. *Mormac Rigel*—3 October 1974.



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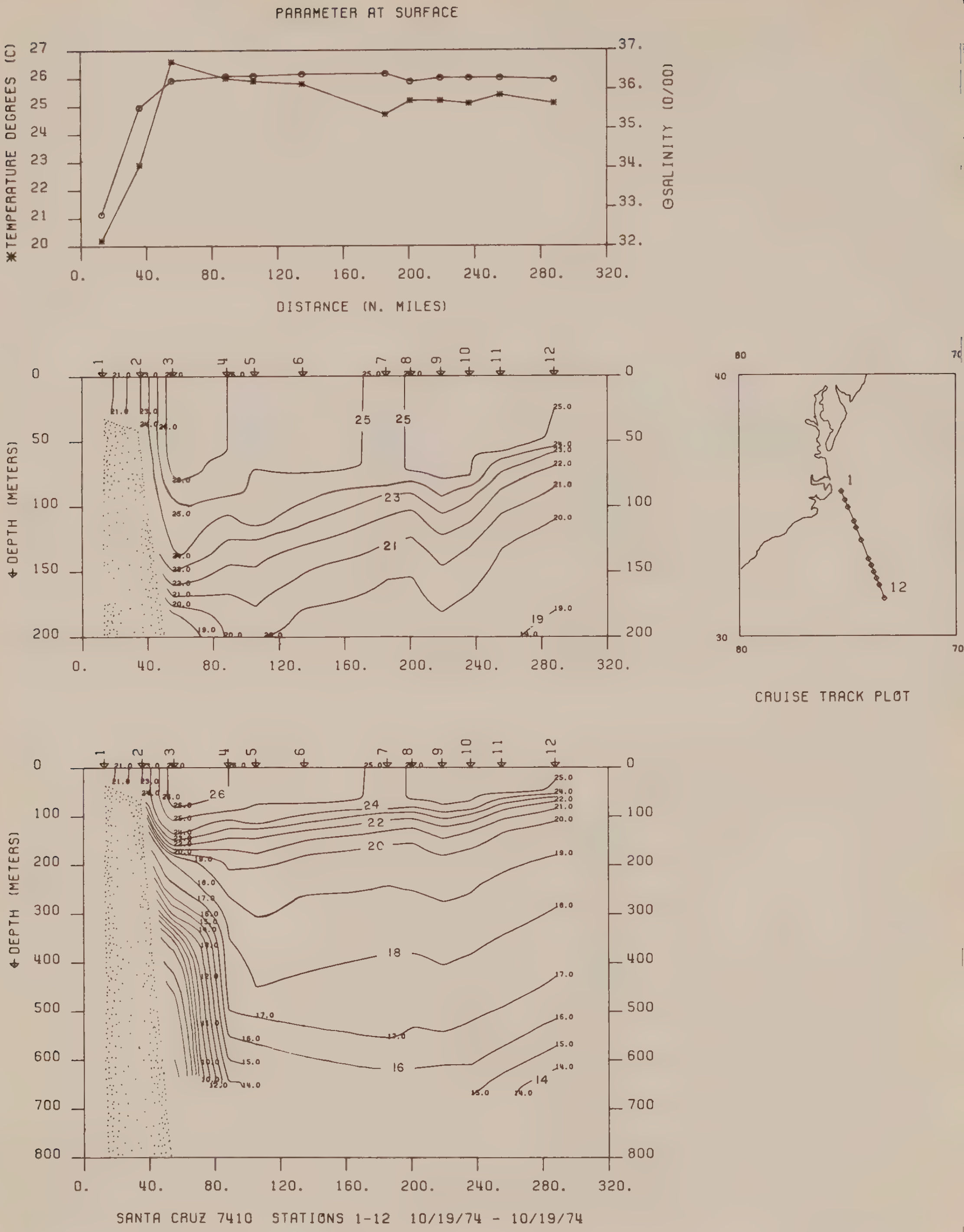
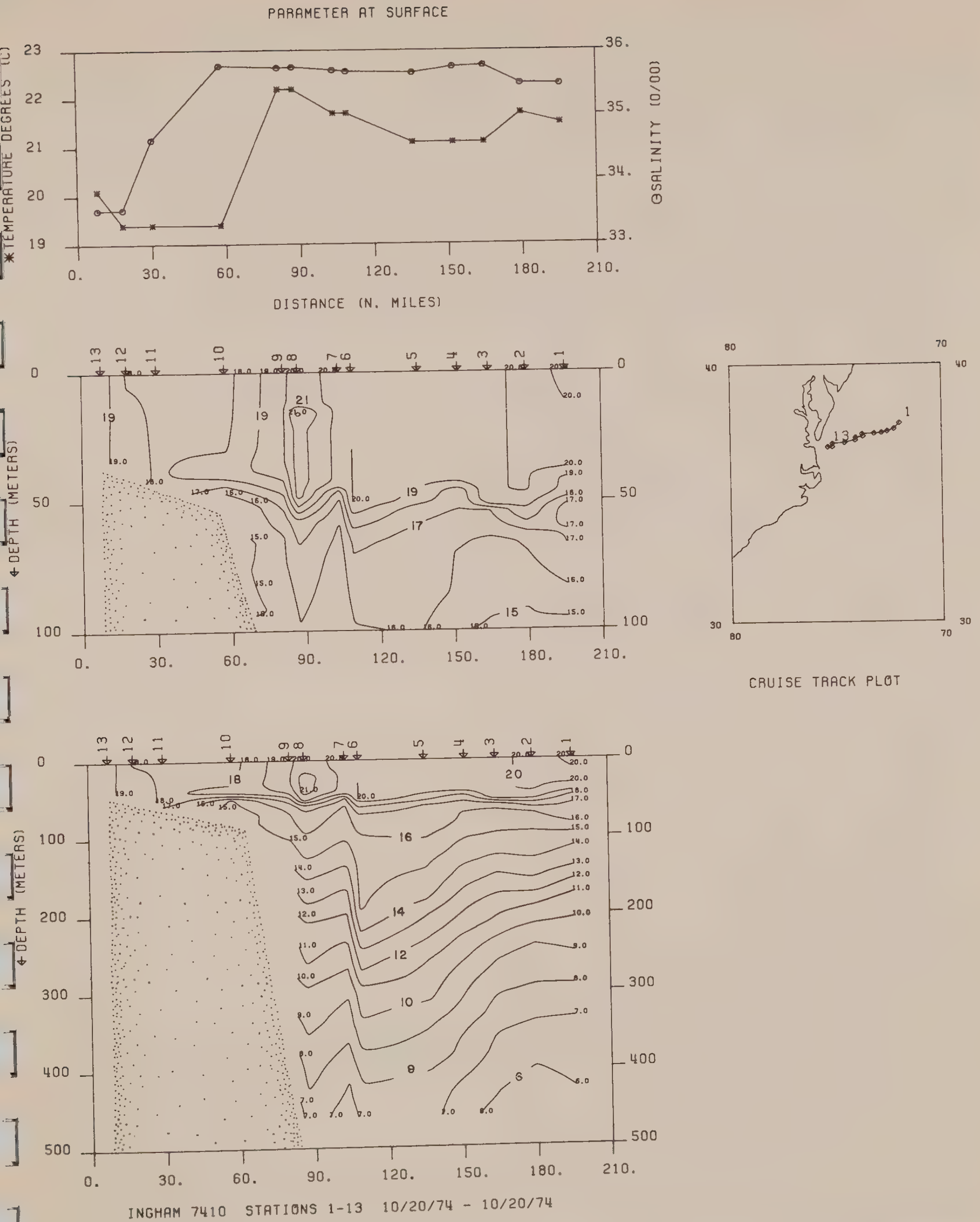
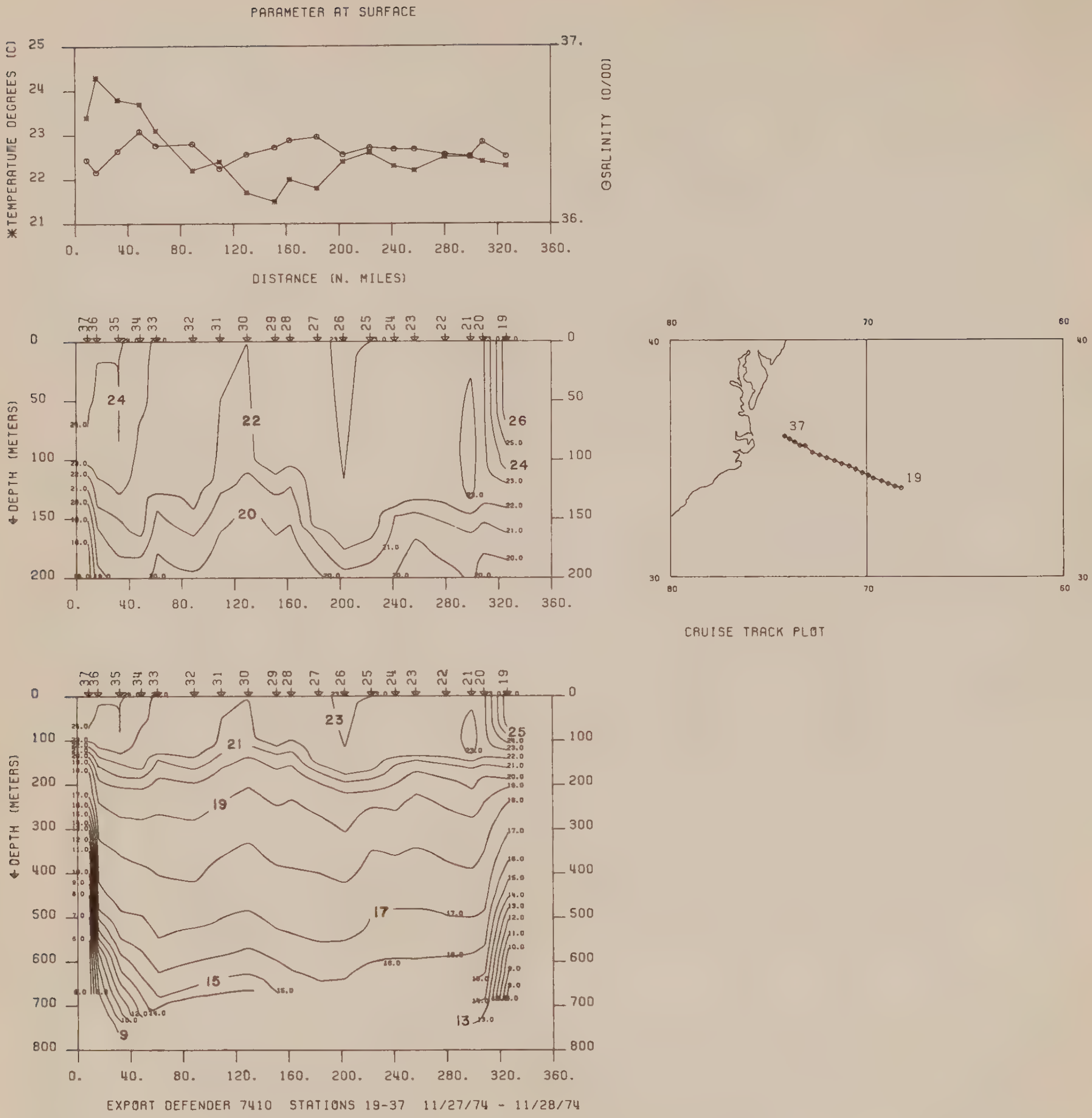


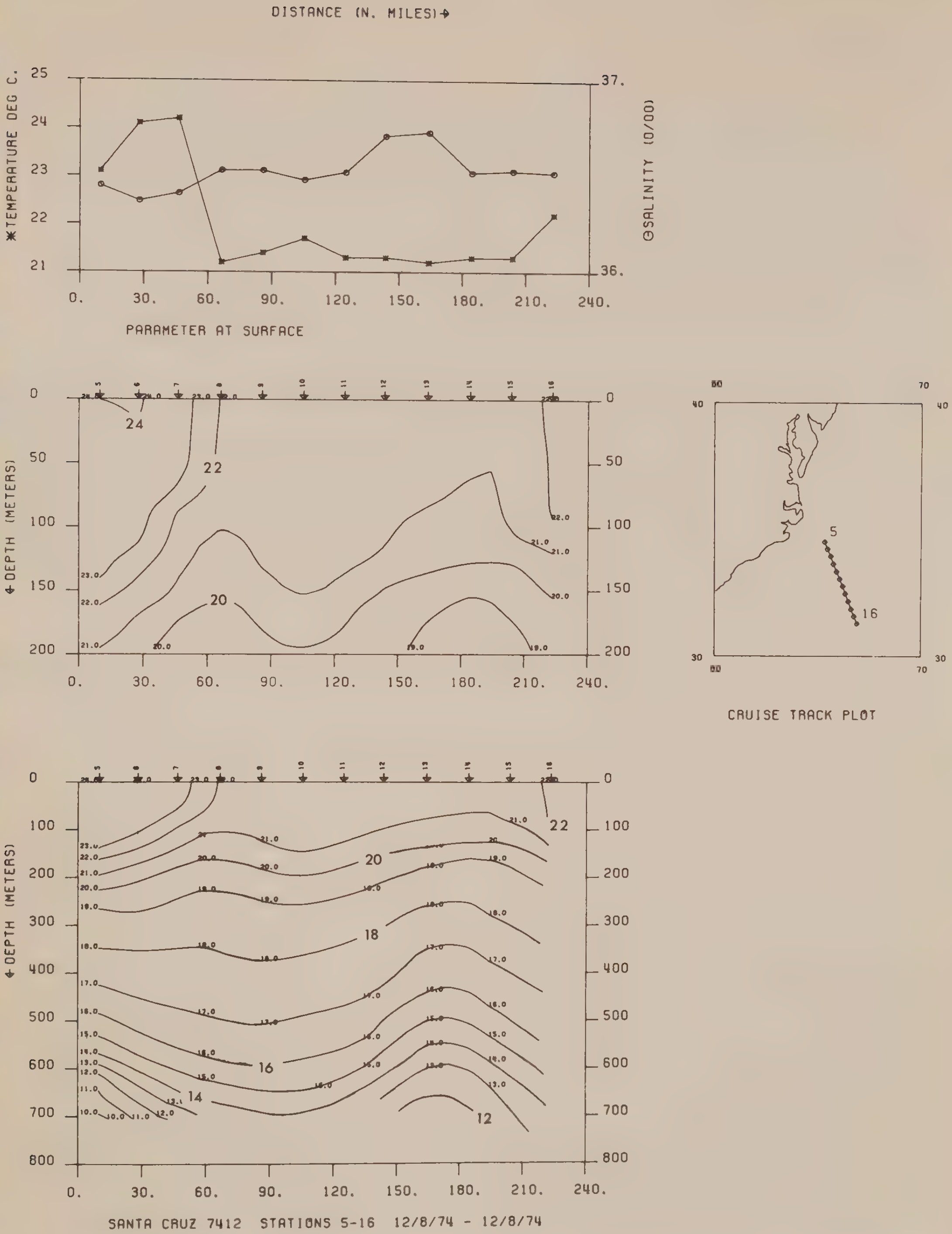
Appendix Figure 32.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribu of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—19 October 1974.



Appendix Figure 33.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. USCGC *Ingham*—20 October 1974.



Appendix Figure 34.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Export Defender*—27-28 November 1974.



Appendix Figure 35.—Horizontal distribution of sea surface temperature (°C) and sea surface salinity (°/₀₀) and vertical distribution of temperature (°C) in the upper 200 and 800 m. *Santa Cruz*—7-8 December 1974.

NOAA Technical Report NMFS SSRF- 710

Midwater Invertebrates from the Southeastern Chukchi Sea: Species and Abundance in Catches Incidental to Midwater Trawling Survey of Fishes, September-October 1970

Bruce L. Wing and Nancy Barr

April 1977

U.S. DEPARTMENT OF COMMERCE
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Positions and sequence of trawling stations during WEBSEC-70. Circles indicate stations where Isaacs-Kidd midwater trawl was used; squares indicate otter trawl was used. (From Quast 1972.) 2

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idwater Invertebrates from the Southeastern Chukchi ea: Species and Abundance in Catches Incidental to Midwater Trawling Survey of Fishes, September-October 1970

BRUCE L. WING and NANCY BARR[1]

ABSTRACT

Midwater invertebrates were collected in the southeastern Chukchi Sea. A 1.8-m Isaacs-Kidd midwater trawl was used at 20 stations to collect 81 semiquantitative samples; a 3-m otter trawl was used at one station to collect two qualitative samples. Data tables list the species collected and their numbers, size range, and displacement volumes for the midwater trawl stations and a species list only for the otter trawl station. One hundred three species of invertebrates were identified from the midwater trawl samples, and 33 species were identified from the otter trawl samples. Amphipods were the most diverse group (40 species) and decapod shrimps the next most diverse (14 species). Numbers of species in a sample varied from 4 to 40 (mean 17). After removal of jellyfishes, the most important contributors in numbers and volume to the catches were euphausiids and mysids.

INTRODUCTION

Western Beaufort Sea Ecological Cruises (WEB- ere a sequence of oceanographic cruises spon- by the U.S. Coast Guard to assess the Alaskan arc- ine environment and biota before major indus- velopment. The Coast Guard enlisted the efforts eral, state and university research groups for the am, and the National Marine Fisheries Service con- d to the first three cruises with studies of kton, midwater invertebrates, and fishes.

intent of the first cruise, WEBSEC-70, which took during September and October 1970, was to ex- the arctic coast from Barrow eastward to Barter Extremely heavy ice conditions in mid-Septem- 70 prevented the Icebreaker *Glacier* from working Beaufort Sea; therefore, an alternative area, the stern Chukchi Sea between Point Lay and Cape e (Fig. 1) was surveyed between 25 September 17 October. Preliminary results of physical, al, geological, and biological investigations for EC-70 were reported by Ingham et al. (1972); and were later published by Quast (1974) and Wing).

report presents data on the invertebrates taken in er trawls made to collect fishes from 25 Septem- 17 October 1970. The data are presented in tabular and are not interpreted, although some apparent g anomalies are discussed. The tables provide a pecies found, numbers of individuals taken, and size range and displacement volume of the specimens of each species. These data are the first attempts to quantitatively assess macroplanktonic and micronektonic invertebrates in the southeastern Chukchi Sea.

METHODS

A 1.8-m Isaacs-Kidd midwater trawl was used to sample at 20 stations for a total of 81 tows (Fig. 1, Appendix Table 1). The trawl had a forward section of 38-mm bar mesh, a rear section of 6-mm bar mesh, and a cod end of 3-mm bar mesh. Cross-sectional areas were calculated to be 2.87 m^2 at the mouth, 1.55 m^2 at the beginning of the 6-mm mesh, and 0.13 m^2 at the beginning of the 3-mm mesh. The depth of tow was recorded by a bathykymograph attached to the bottom of the depressor. Tows were standardized for a length of 3.7 km at an estimated vessel speed of 4 knots. At least four tows were made at each of the 20 stations, two on one bearing and two on the reciprocal bearing. Trawling was generally done at night in areas relatively free of ice. The choice of sampling depths was dependent on water depths and on whether or not the samples were intended to be replicates or were to examine depth distributions (Quast 1974).

At one station (No. 8—Fig. 1) two trawls were made with a 3-m, 38-mm mesh otter trawl (shrimp try net) to collect bottom fishes and invertebrates.

Large scyphomedusans and most hydromedusans taken in the trawls were discarded in the field after the sizes and numbers of each species of scyphomedusan and the volumes of hydromedusans had been recorded. The other invertebrates were preserved in 5% Formalin.

In preparation for examining the invertebrates in the laboratory, formalin was washed from the samples and

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vest and Alaska Fisheries Center Auke Bay Laboratory, National sheries Service, NOAA, P.O. Box 155, Auke Bay, AK 99821.

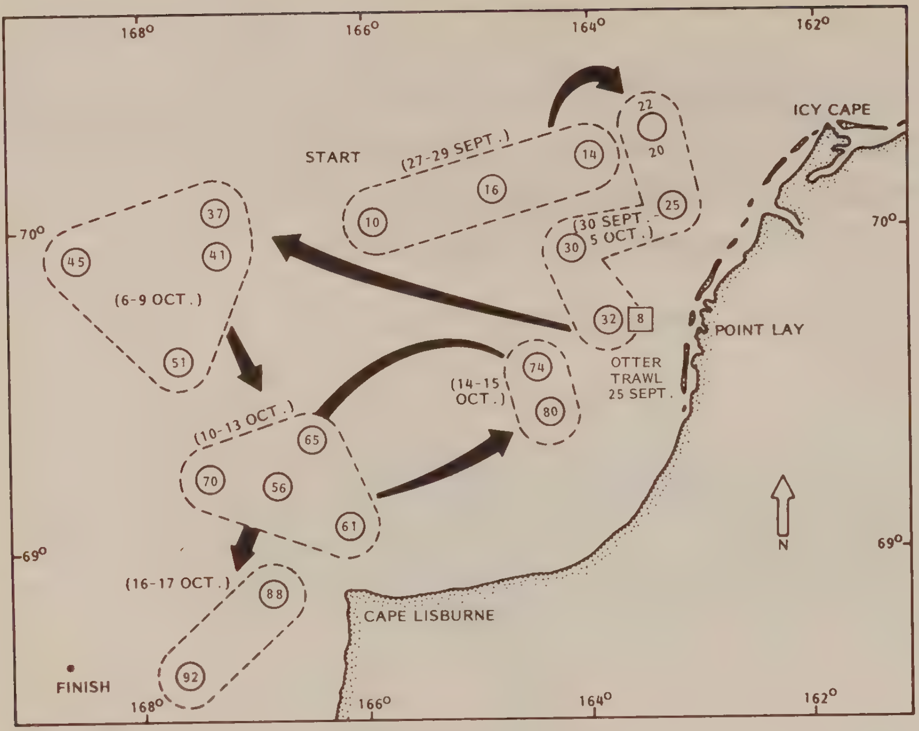

Figure 1.—Position
quence of trawling sta
ing WEBSEC-70. Ci
cate stations where Is
midwater trawl w
squares indicate otter
used. (From Quast, 1

they were stored in 40% isopropyl alcohol. Each sample was examined first in its entirety for rare species. For small samples, total counts were made for each species of invertebrate, and maximum and minimum size ranges were recorded. When large numbers of euphausiids or mysids were present, the collections were subsampled with a Folsom plankton splitter (McEwen et al. 1954). The subsamples always contained more than 500 individuals.

Identifications (to species when possible) were based on the following taxonomic references: Banner (1948a, 1948b, 1950, 1954); Barnard (1958, 1962a, 1962b, 1962c, 1964, 1973); Boden et al. (1955); Bowman (1973, 1960); Brodskii (1950); Coe (1904, 1905); Dawson (1971); Dunbar (1954); Gurjanova (1951); Holmquist (1959, 1965); Leung (1971); G. E. MacGinitie (1955); N. MacGinitie (1959); Naumov (1960); Rathbun (1904); Sars (1895, 1900); Shoemaker (1955); Vanhöffen (1906); and Zimmer (1926). Except for decapod shrimps, lengths are greatest body lengths to the nearest millimeter and do not include antennae, rostra, or tentacles. Decapod shrimp lengths are for the carapace (insertion of eye to dorsal posterior margin). Displacement volumes to the nearest 0.5 ml were taken on the drained lots of each species sorted from a sample. The volumes were measured with 10-, 25-, 100-, or 500-ml graduated cylinders. All sorting and measuring was done 1-4 yr after the specimens were collected; thus shrinkage due to preservation was stabilized. Displacement volumes were obtained only for samples processed in the last 4 mo of sorting.

RESULTS

The 81 samples from the 20 midwater traw
contained 103 specimens of invertebrates (
Amphipods had the greatest number of species
decapod shrimps the second largest (14). The n
invertebrate species per sample ranged from
(mean, 17). The scyphomedusans and hydro
discarded in the field contributed most to the
the catches. In the preserved material, euphau
mysids were the most abundant invertebrate
major contributors to the biomass (Appendix

Thirty-three species of invertebrates were
from the two samples taken by the 3-m otte
station 8 (Table 2). The list of invertebrate spe
station 8 plus the benthic invertebrates taken i
water trawl samples supplement the more exte
of benthic invertebrates from the southeaster
Sea given by McCauley (1964), Sparks an
(1966), and Naidu and Sharma (1972). Three
gastropods, 4 bivalves, 2 mysids, 2 iso
amphipods, 9 decapod crustaceans, and 1 asci
collected by the otter trawl.

DISCUSSION

The three sizes of meshes in the Isaacs-K
water trawl used in the sampling were 3-mm c
mm rear section, and 38-mm forward section
the invertebrates captured were so small tha
them undoubtedly passed through the larger m

Subclass Order Genus species	Stations where collected
COELENTERATA	
HYDROZOA	
Aglantha digitale (O. F. Müller)	All stations
Cuspidella mertensii (Brandt)	10, 14, 16, 20, 25, 30, 32, 37, 41, 45, 51, 56, 65, 70, 74, 80, 88
SCYPHOZOA	
Aurelia aurita (Linneaus)	10, 14, 16, 25, 30, 32, 37, 41, 45, 51, 56, 65, 70, 74, 80, 88, 92
Chrysaora melanaster Brandt	10, 16, 20, 22, 25, 30, 37, 41, 45, 51, 56, 61, 65, 70, 74, 80, 92
Cyanea capillata (Linneaus)	All stations
ANTHOZOA	
Stomphia sp.	16, 20, 30, 37, 41, 65, 80, 88, 92
RHYNCHOCOELA	
NEMERTINEA	
Cerebratulus sp. (? *herculeus* Coe)	88
MOLLUSCA	
GASTROPODA	
Clione limacina (Phipps)	All stations
Spiratella helicina (Phipps)	14
Margarites sp.	88
Natica clausa Broderip and Sowerby	88
Buccinum sp. (? *elatius* (Middendorf))	65
BIVALVIA	
Nucula tenuis (Montagu)	88
SIPUNCULOIDEA	
SIPUNCULOIDEA	
Phascolosoma sp.	80, 88
ECHIUROIDEA	
ECHIURIDA	
Echiurus echiurus alaskanus Fisher	10, 14, 30, 32
ANNELIDA	
CHAETOPODA	
Polychaeta	
Antinoe badia Theel	65, 70
A. sarsi Malmgren	70
Eusyllis (?) sp.	37
Nephtys paradoxa Malmgren	88
Glycinde sp.	37, 45
Lumbrineris fragilis (O. F. Müller)	61, 65
L. similabris (Treadwell)	65, 88
Axiothella (?) sp.	37, 88
Chone cincta Zachs	45

Subclass Order Genus species	Stations where collected
ARTHROPODA	
CRUSTACEA	
Copepoda	
Calanoida	
Calanus cristatus Krøyer	10, 56, 65, 70
C. finmarchicus (Gunnerus) *s.l.*	10, 51, 56, 65
Eucalanus bungii Giesbrecht	56
Malacostraca	
Mysidacea	
Mysis litoralis (Banner)	20, 22, 25, 30, 32, 37, 45, 51, 56, 61, 65, 70, 74, 80, 88, 92
M. oculata (Fabricius)	20, 25, 30, 32, 37, 45, 51, 56, 61, 65, 70, 74, 80, 88, 92
M. polaris Holmquist	10, 41
Acanthomysis pseudomacropsis (Tattersall)	16, 32, 51, 56, 61, 65, 70, 80, 88, 92
Acanthomysis sp.	45, 56, 61, 65, 70, 80
Neomysis rayii (Murdock)	10, 16, 20, 22, 25, 32, 41, 45, 51, 56, 61, 65, 70, 74, 80, 88, 92
Pseudomma truncatum Smith	88
Cumacea	
Diastylis glabra (C. Zimmer)	20, 30, 32, 61, 74, 80, 88, 92
D. (?) *lepechini* C. Zimmer	32, 61, 80
Eudorella emarginata (Krøyer)	88
Leucon nasica (Krøyer)	32, 70
Isopoda	
Dajidae[1]	32, 45, 56, 80, 88
Amphipoda	
Hyperia galba (Montagu)	37, 45, 51, 56, 80, 88, 92
H. medusarum (Müller)	10, 14, 16, 20, 22, 30, 45, 56, 65, 70, 74, 80, 88, 92
Hyperoche medusarum (Krøyer)	56, 92
Parathemisto libellula (Lichtenstein)	10, 41, 51, 56, 61, 88
Acanthonotozoma serratum (Fabricius)	32, 56, 61, 88
Ampelisca macrocephala Lilljeborg	30, 32, 65, 74, 80, 88
Byblis gaimardii (Krøyer)	65, 70, 80
Atylus bruggeni (Gurjanova)	32, 61, 80
Apherusa glacialis (Hansen)	10, 14, 16, 20, 25
Protomedia stephenseni Shoemaker	30, 32, 65, 74, 80, 88
Rhachotropis aculeata (Lepechin)	32, 37, 61, 65, 70, 80, 88
R. oculata (Hansen)	30, 92
Gammaracanthus loricatus (Sabine)	37
Gammarus wilkitzkii Birula	10, 14, 20, 22, 25, 30, 37, 74, 80
G. zaddachi Sexton	14, 80
Maera loveni (Bruzelius)	56, 61, 70
M. sp. (? *danae* (Stimpson))	10
Melita formosa Murdoch	32, 61, 65, 70, 80, 88
M. sp. (? *desdichada* Barnard)	56, 61, 65, 70, 88

Table 1.—Continued.

PHYLUM CLASS Subclass Order *Genus species*	Stations where collected
Pontoporeia femorata Krøyer)	30, 70
Priscillina sp. (? *armata* (Boeck))	20
Ericthonius tolli Bruggen	16, 80
Ischyrocerus latipes Krøyer	80
Anonyx lilljeborgi Boeck	32, 61
A. nugax (Phipps)	30, 61, 74, 80, 88
Hippomedon propinquus Sars	30, 32, 61, 70, 80
Pseudalibrotus glacialis Sars	10, 14, 16, 20, 25, 45, 74, 80
P. nanseni Sars	10, 14, 20, 22, 25, 37, 74, 80, 88
Tryphosa sp.	30
Acanthostepheia behringiensis (Lockington)	30, 32, 37, 74, 80
Monoculodes borealis Boeck	32, 45, 61, 65, 74, 80
M. sp. (? *diamesus* Gurjanova)	32
Paraphoxus milleri (Thorsteinson)	20, 22, 30, 32, 70, 74
Pleustes panopla (Krøyer)	32, 61
Syrrhoe crenulata Goes	30, 32, 65
Euphausiacea	
Thysanoessa inermis (Krøyer)	10, 16, 20, 22, 25, 30, 32, 37, 41, 45, 51, 56, 65, 70, 74, 80, 88, 92
T. longipes Brandt	45, 70, 74, 80, 88
T. raschii (M. Sars)	All stations
Decapoda	
Pandalus borealis Krøyer	41, 70
P. goniurus Stimpson	10, 14, 16, 30, 32, 37, 41, 45, 51, 57, 61, 65, 70, 74, 80, 88, 92
Pandalus sp.	10
Eualus fabricii (Krøyer)	32, 61, 65, 74, 80, 88
E. gaimardii (M. Edwards)	10, 16, 32, 45, 51, 56, 61, 65, 70, 74, 80, 88, 92
E. macilenta (Krøyer)	32, 41, 61, 65, 70
E. stoneyi (Rathbun)	10, 45, 56, 70, 88, 92
Eualus sp.	70, 74, 80, 88
Lebbeus groenlandicus (J. C. Fabricius)	61
Hippolytidae[2] unidentified	10, 74
Argis lar (Owen)	30, 32, 37, 56, 61, 65, 70, 74, 80, 92
A. crassa (Rathbun)	32, 61
Crangon communis Rathbun	32, 70
C. dalli Rathbun	56, 61, 88, 92
Crangon sp. (? *intermedia* Stimpson)	61
Sclerocrangon boreas (Phipps)	32
Chionoecetes opilio (O. Fabricius)	80
Brachyura (zoeae)[3]	10, 14, 16, 20, 22, 25, 37
Brachyura (megalopae)[3]	All stations
Pagurus trigonocheirus (Stimpson)	88
Paguridea (zoeae)[4]	10, 14, 16, 20, 22, 25, 30, 32, 37, 41, 45, 51, 56, 61, 65, 70, 74, 88, 92
Paguridae (glaucothoe)[4]	10, 14, 16, 25, 30, 32, 37, 41, 45, 51, 56, 61, 65, 70, 74, 80, 88, 92
CHAETOGNATHA	
CHAETOGNATHA	
Sagitta elegans Verrill	10, 37, 51, 56, 65, 70, 74, 88, 92
ECHINODERMATA	
OPHIUROIDEA[5]	88

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[1] Family name. Parasitic on mysids.

[2] Family name.

[3] Tribe name. Within the brachyuran larvae, no attempt was made to separate species. Searches through selected samples yielded both *Chionocetes opilio* (O. Fabricius) and *Hyas coarctatus* Leach.

[4] Subtribe name. Within the pagurideans, no attempt was made to distinguish between zoeae of Paguridae (family name) and Lithodidae (family name). Glaucothoe were all Paguridae.

[5] Genus and species undetermined.

Table 2.—Partial listing of invertebrates from otter trawl samples off Point Lay, Alaska.

CLASS
  Subclass
    Genus species

GASTROPODA
    Buccinum sclariforme Möller
    Margaritopsis pribiloffensis (Dall)
    Dendronotus dalli Bergh
BIVALVIA
    Musculus discors (Linnaeus)
    Yoldia scissurata Dall
    Serripes groenlandicus (Bruggen)
    Mya truncata Linnaeus
MALACOSTRACA
  Mysidacea
    Mysis oculata and/or *M. litoralis*
    Neomysis rayii (Murdock)
  Isopoda
    Tecticeps alaskensis Richardson
    Synidotea bicuspida (Owen)
  Amphipoda
    Anonyx nugax (Phipps)
    Tryphosa sp.
    Acanthostepheia behringiensis (Lockington)
    Paroediceros lynceus (M. Sars)

CLASS
  Subclass
    Genus species

    Protomedia fasciata Krøyer
    Ischyrocerus latipes Krøyer
    I. megalops Sars
    Ericthonius difformis M. Edwards
    E. tolli Bruggen
    Pleustes panopla (Krøyer)
    Rhacotropis aculeata (Lepechin)
    Dulichia spinossisma Krøyer
  Decapoda
    Pandalus goniurus Stimpson
    Eualus fabricii (Krøyer)
    E. gaimardii (M. Edwards)
    Lebbeus groenlandicus (J. C. Fabricius)
    Spinontocaris phippsii (Krøyer)
    Argis lar (Owen)
    Sclerocrangon boreas (Phipps)
    Hyas coarctatus Leach
    Pagurus trigonocheirus (Stimpson)
ASCIDIACEA
    Boltenia ovifera (Linnaeus)

the resulting catches should be considered only as
antitative, they do provide indicators of the kinds
eneral quantities of midwater invertebrates present
southeastern Chukchi Sea.

terms mesoplankton, macroplankton, micronek-
d benthos may be applied to various grouping of
ebrates collected with the Isaacs-Kidd midwater
the Chukchi Sea during WEBSEC-70. None of
ns are precisely defined, but they provide criteria
luation of catches by those who may wish to com-
he species and quantities reported in Appendix
with other sets of data.

plankters are zooplankters quantitatively retain-
a 0.2-mm mesh net and having a total body length
an 10 mm. Large mesoplankters are those with a
gth greater than 1 mm. The midwater trawl used
WEBSEC-70 did not quantitatively retain large
lankters, as evidenced by the low frequency and
umbers of copepods *Calanus finmarchicus s.l.*
calanus bungii and the chaetognath *Sagitta*
in the catches. These mesoplankters were widely
uted and abundant in plankton samples taken
0.57-mm mesh plankton net during the same
Wing 1974).

mals of the macroplankton and micronekton are
nough to be identified with the naked eye. There is
r size limit and the lower size limit (5-10 mm
dependent on the taxa involved and the knowl-
f the researcher. Animals of the micronekton are
mm long and can swim well enough to avoid stan-
h plankton nets. Because the swimming ability of
ans, cephalopods, and fishes increases with size,
plankton and micronekton are not precisely defin-
early separable categories. Within the size range
plankton and micronekton, the midwater trawl
ring WEBSEC-70 would collect quantitatively only the large scyphomedusans and the hydromedusan *Cuspidella mertensii.* Although herding occurs, much of the macroplankton and micronekton passes through the 6- and 38-mm meshes at the front of the net. Many of the hydromedusan *Aglantha digitale*, the euphausiids, and the mysids undoubtedly passed through the net, although these were the most abundant organisms in the catches (Appendix Table 2). The retention of macroplankton- and micronekton-sized medusans, amphipods, mysids, euphausiids, and shrimps by the midwater trawl used during WEBSEC-70 indicates that they were quite abundant and important in the trophic structure of the area but does not measure their abundance.

Many of the species collected by the midwater trawl in the Chukchi Sea are considered to be benthic animals, i.e., they live on (epibenthos), in (endobenthos), or just off (hyperbenthos) the bottom. Many of the benthic animals, especially polychaetes, mysids, cumaceans, gammarid amphipods, and shrimps, may leave the bottom at night and become part of the macroplankton and micronekton. Except for stations 8 and 14 (Table 1), all sampling was at night: consequently some benthic animals were well represented in the collection.

The shallowness of the area (22-54 m) sampled by WEBSEC-70 contributed to the occurrence of benthic animals in the midwater trawl catches. Benthic animals, which rise off bottom at night, are likely to contribute more to the macroplankton and micronekton in shallow waters than in deeper waters. Additionally, wave-induced turbulence and ice rafting may have placed in suspension some endobenthos (i.e., benthic snails, sipunculids, and echiuroids), which would not normally be off bottom. The net struck bottom only on station 88. Samples from that station contained two species of snails (*Margarites* sp. and *Natica clausa*), a clam (*Nucula* *tenuis*), adult hermit crabs (*Pagurus* sp.), and brittle stars (Ophiuroidae) in addition to more usual planktonic species (Table 1, Appendix Table 2).

SUMMARY

One hundred three species of invertebrates were taken in Isaacs-Kidd midwater trawl samples from the southeastern Chukchi Sea during WEBSEC-70. Thirty-three species were taken by otter trawl. Numbers of invertebrate species in a midwater trawl sample varied from 4 to 40 (mean, 17). Amphipods were the most varied group (40 species) and shrimps the next most varied group (14 species).

After removal of hydroid and scyphozoan jellyfishes, euphausiids and mysids contributed the most to the biomass and numbers of the midwater invertebrates retained by the midwater trawl.

ACKNOWLEDGMENTS

We thank Alexander Hoke for the design and execution of the computer program for Appendix Table 2. We thank the U.S. Coast Guard Oceanographic Unit and the Marine Sciences section of the Icebreaker *Glacier* for assistance in collection of samples from the Chukchi Sea at a time of the year not previously sampled.

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Appendix Table 1.—Station data for WEBSEC-70 fish trawl stations (Quast 1972).

Station	Data and inclusive time (Bering Standard)		Approximate position		Depth of water (m)	Hauls		
			Lat. N	Long. W		No.	Type[1]	and depths (m)[2]
8	Sept. 25	(1115-1253)	69°45′	163°34′	26	2	B	26, 26
10	Sept. 27	(1917-2207)	70°04′	165°57′	44	4	R	11
14	Sept. 29	(0518-0817)	70°17′	165°02′	51	4	R	11
16	Sept. 29	(1721-2002)	70°16′	163°58′	53	4	R	11
20	Sept. 30	(1740-2025)	70°20′	163°24′	42	4	R	12
22	Oct. 1	(1734-2103)	70°20′	163°25′	35	4	R	12
25	Oct. 2	(1731-2036)	70°07′	163°14′	33	4	R	12
30	Oct. 4	(1756-2137)	69°58′	164°07′	31	5	M	2, 5, 10, 13, 19
32	Oct. 5	(1831-2104)	69°48′	163°49′	26	4	R	12
37	Oct. 6	(1727-1956)	70°07′	167°36′	49	4	R	12
41	Oct. 7	(1752-2014)	69°57′	167°31′	44	4	M	10, 10, 12, 22
45	Oct. 8	(1816-2058)	69°57′	168°38′	44	4	M	2, 9, 13, 20
51	Oct. 9	(1744-2024)	69°36′	167°36′	48	4	M	2, 7, 14, 20
56	Oct. 10	(1940-2229)	69°14′	166°53′	44	4	M	2, 9, 18, 23
61	Oct. 11	(1755-2015)	69°05′	166°13′	29	4	M	8, 13, 16, 23
65	Oct. 12	(1755-2016)	69°21′	166°45′	36	4	M	8, 13, 16, 22
70	Oct. 13	(1735-1958)	69°12′	167°38′	39	4	M	8, 13, 18, 22
74	Oct. 14	(1723-1946)	69°35′	164°29′	22	4	M	2, 8, 13, 18
80	Oct. 15	(1814-2055)	69°27′	164°43′	30	4	M	2, 8, 13, 22
88	Oct. 16	(1917-2205)	68°55′	166°47′	45	4	M	2, 11, 24, 40-45
92	Oct. 17	(1733-2014)	68°36′	167°41′	54	4	M	2, 13, 17, 33

[1] Hauls approximately 30 min at depth; all hauls except those at station 8 were made with a 6-foot diameter Isaacs-Kidd trawl with 76-mm (stretched measurement) webbing and 13-mm liner. Hauls at station 8 were made on bottom with a shrimp try net, with 10-foot opening and 38-mm webbing. M = multidepth hauls with 6-foot Isaacs-Kidd trawl, B = shrimp try net on bottom, and R = replicated hauls at single depth with 6-foot Isaacs-Kidd trawl.

[2] Depth of footrope or depressor.

Appendix Table 2.—Catches of invertebrates by 1.8-m Isaacs-Kidd midwater trawl in the southeastern Chukchi Sea.

NOTES:

Mysis litoralis and *Mysis oculata* both occur in the samples but were not tallied separately and therefore are listed as *Mysis oculata/litoralis.*

Size ranges are total body length exclusive of antennae, rostra, and tentacles for most animals except: carapace length of decapod shrimp and bell diameter of medusans.

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 10 DATE: SEP 27 1970
LATITUDE: 70 4 0 NORTH LONGITUDE: 165 57 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 19:50

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	20.0
CUSPIDELLA MERTENSII	2	-- - --	--
CYANEA CAPILLATA	2	-- - --	10.0
ECHIURUS ECHIURUS ALASKANUS	1	-- - --	--
CLIONE LIMACINA	14	-- - --	--
SAGITTA ELEGANS	3	20.00- 24.00	--
CALANUS FINMARCHICUS S.L.	5	-- - --	--
NEOMYSIS RAYII	1	-- - 29.00	--
PARATHEMISTO LIBELLULA	2	14.00- 21.00	--
PSEUDALIBROTUS GLACIALIS	2	12.00- 14.00	--
PSEUDALIBROTUS NANSENI	8	8.00- 17.00	--
THYSANOESSA INERMIS	94	8.00- 20.00	4.0
THYSANOESSA RASCHII	490	7.00- 24.00	12.0
PANDALUS GONIURUS	147	2.00- 15.00	21.0
PANDALUS SP.	6	-- - 3.00	--
HIPPOLYTIDAE SP.	2	-- - 3.00	--
BRACHYURA - MEGALOPA	748	-- - --	10.0
PAGURIDEA ZOEA	127	-- - --	--
PAGURIDEA GLAUCOTHOE	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 10 DATE: SEP 27 1970
LATITUDE: 70 4 0 NORTH LONGITUDE: 165 57 0 WEST
HAUL: 2 DEPTH: 11 METERS TIME: 20:38

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	6	-- - --	--
CHRYSAORA MELANASTER	8	150.00-300.00	--
CYANEA CAPILLATA	16	40.00-200.00	--
ECHIURUS ECHIURUS ALASKANUS	4	-- - --	--
CLIONE LIMACINA	6	-- - --	--
CALANUS FINMARCHICUS S.L.	1	-- - 4.00	--
NEOMYSIS RAYII	4	29.00- 35.00	--
HYPERIA MEDUSARUM	2	11.00- 18.00	--
GAMMARUS WILKITZKII	1	-- - 14.00	--
MAERA SP (? DANAE)	1	-- - 15.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 12.00	--
PSEUDALIBROTUS NANSENI	1	-- - 17.00	--
THYSANOESSA INERMIS	2260	10.00- 25.00	141.1
THYSANOESSA RASCHII	870	8.00- 25.00	35.3
PANDALUS GONIURUS	138	3.00- 14.50	42.5
EUALUS GAIMARDII	2	6.50- 7.00	0.5
BRACHYURA - MEGALOPA	370	-- - --	--
PAGURIDEA ZOEA	120	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 10 DATE: SEP 27 1970
LATITUDE: 70 4 0 NORTH LONGITUDE: 165 57 0 WEST
HAUL: 3 DEPTH: 11 METERS TIME: 21:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	14.1
CUSPIDELLA MERTENSII	4	-- - --	--
AURELIA AURITA	1	-- - 60.00	--
CYANEA CAPILLATA	8	60.00-220.00	--
ECHIURUS ECHIURUS ALASKANUS	3	-- - --	--
CLIONE LIMACINA	4	-- - --	--
NEOMYSIS RAYII	1	-- - 30.00	--
APHERUSA GLACIALIS	1	-- - 12.00	--
GAMMARUS WILKITZKII	3	20.00- 23.00	--
PSEUDALIBROTUS NANSENI	3	11.00- 20.00	--
THYSANOESSA INERMIS	1531	10.00- 22.00	--
THYSANOESSA RASCHII	747	10.00- 20.00	96.8
PANDALUS GONIURUS	152	3.00- 13.00	22.0
EUALUS GAIMARDII	1	-- - 6.00	--
EUALUS STONEYI	1	-- - 8.00	0.4
HIPPOLYTIDAE SP.	1	-- - 2.50	--
BRACHYURA - MEGALOPA	137	-- - --	--
PAGURIDEA ZOEA	100	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 10 DATE: SEP 27 1970
LATITUDE: 70 4 0 NORTH LONGITUDE: 165 57 0 WEST
HAUL: 4 DEPTH: 11 METERS TIME: 22:07

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	18.0
CUSPIDELLA MERTENSII	1	-- - --	--
AURELIA AURITA	1	-- - 60.00	--
CHRYSAORA MELANASTER	1	-- - 90.00	--
CYANEA CAPILLATA	9	40.00-180.00	--
ECHIURUS ECHIURUS ALASKANUS	17	-- - --	--
CLIONE LIMACINA	5	-- - --	--
SAGITTA ELEGANS	2	-- - --	--
CALANUS CRISTATUS	1	-- - 9.00	--
MYSIS POLARIS	1	-- - --	--
NEOMYSIS RAYII	2	31.00- 37.00	--
APHERUSA GLACIALIS	1	-- - 12.00	--
PSEUDALIBROTUS GLACIALIS	0	10.00- 19.00	--
PSEUDALIBROTUS NANSENI	3	-- - --	--
THYSANOESSA INERMIS	287	12.00- 26.00	--
THYSANOESSA RASCHII	213	9.00- 22.00	--
PANDALUS GONIURUS	207	3.00- 14.00	--
BRACHYURA - ZOEA	1	-- - --	--
BRACHYURA - MEGALOPA	130	-- - --	--
PAGURIDEA ZOEA	70	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 14 DATE: SEP 29 1970
LATITUDE: 70 17 0 NORTH LONGITUDE: 165 2 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 05:48

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	350.0
CUSPIDELLA MERTENSII	6	-- -120.00	--
AURELIA AURITA	1	-- - 60.00	--
CYANEA CAPILLATA	3	30.00-220.00	--
ECHIURUS ECHIURUS ALASKANUS	1	-- - --	--
CLIONE LIMACINA	1	-- - --	--
SPIRATELLA HELICINA	1	-- - --	--
HYPERIA MEDUSARUM	1	-- - 11.00	--
APHERUSA GLACIALIS	6	9.00- 10.00	--
GAMMARUS WILKITZKII	7	17.00- 36.00	1.5
GAMMARUS ZADDACHI	1	-- - 6.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 15.00	--
THYSANOESSA RASCHII	1	-- - 8.00	--
PANDALUS GONIURUS	1	-- - 11.00	0.8
BRACHYURA - ZOEA	9	-- - --	--
BRACHYURA - MEGALOPA	120	-- - --	--
PAGURIDEA ZOEA	45	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 14 DATE: SEP 29 1970
LATITUDE: 70 17 0 NORTH LONGITUDE: 165 2 0 WEST
HAUL: 2 DEPTH: 11 METERS TIME: 06:30

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	337.0
CUSPIDELLA MERTENSII	1	-- - 60.00	--
CYANEA CAPILLATA	2	80.00-120.00	--
CLIONE LIMACINA	1	-- - --	--
HYPERIA MEDUSARUM	1	-- - 19.00	--
PSEUDALIBROTUS NANSENI	3	16.00- 17.00	--
BRACHYURA - ZOEA	11	-- - --	--
BRACHYURA - MEGALOPA	39	-- - --	--
PAGURIDEA ZOEA	54	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 14 DATE: SEP 29 1970
LATITUDE: 70 17 0 NORTH LONGITUDE: 165 2 0 WEST
HAUL: 3 DEPTH: 11 METERS TIME: 07:35

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	35.0
AURELIA AURITA	2	50.00- 80.00	--
CLIONE LIMACINA	5	-- - --	--
APHERUSA GLACIALIS	1	-- - 10.00	--
GAMMARUS ZADDACHI	1	-- - 27.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 13.00	--
PSEUDALIBROTUS NANSENI	1	-- - 19.00	--
BRACHYURA - ZOEA	22	-- - --	--
BRACHYURA - MEGALOPA	275	-- - --	3.6
PAGURIDEA ZOEA	118	-- - --	1.8
PAGURIDEA GLAUCOTHOE	18	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 14 DATE: SEP 29 1970
LATITUDE: 70 17 0 NORTH LONGITUDE: 165 2 0 WEST
HAUL: 4 DEPTH: 11 METERS TIME: 08:14

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	100.0
CUSPIDELLA MERTENSII	1	-- - 80.00	--
AURELIA AURITA	2	60.00- 70.00	--
CYANEA CAPILLATA	7	30.00-220.00	--
ECHIURUS ECHIURUS ALASKANUS	1	-- - --	--
CLIONE LIMACINA	1	-- - --	--
GAMMARUS WILKITZKII	1	-- - 24.00	--
THYSANOESSA RASCHII	1	-- - 8.00	--
BRACHYURA - ZOEA	22	-- - --	--
BRACHYURA - MEGALOPA	143	-- - --	2.3
PAGURIDEA ZOEA	454	-- - --	10.0
PAGURIDEA GLAUCOTHOE	21	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 16 DATE: SEP 29 1970
LATITUDE: 70 16 0 NORTH LONGITUDE: 163 58 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 17:52

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CUSPIDELLA MERTENSII	2	100.00-100.00	--
CHRYSAORA MELANASTER	2	120.00-120.00	--
CYANEA CAPILLATA	10	50.00- 90.00	--
CLIONE LIMACINA	7	-- - --	--
APHERUSA GLACIALIS	1	-- - 12.00	--
THYSANOESSA INERMIS	4	8.00- 21.00	--
THYSANOESSA RASCHII	31	8.00- 20.00	--
BRACHYURA - ZOEA	13	-- - --	--
BRACHYURA - MEGALOPA	220	-- - --	3.5
PAGURIDEA ZOEA	224	-- - --	5.0
PAGURIDEA GLAUCOTHOE	53	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 16 DATE: SEP 29 1970
LATITUDE: 70 16 0 NORTH LONGITUDE: 163 58 0 WEST
HAUL: 2 DEPTH: 12 METERS TIME: 18:29

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	200.0
CUSPIDELLA MERTENSII	2	100.00-100.00	--
CHRYSAORA MELANASTER	2	270.00-320.00	--
CYANEA CAPILLATA	16	70.00-200.00	--
STOMPHIA SP.	1	-- - --	--
NEOMYSIS RAYII	1	-- - 30.00	--
GAMMARUS WILKITZKII	1	-- - 35.00	--
THYSANOESSA RASCHII	1	-- - 20.00	--
BRACHYURA - MEGALOPA	3	-- - --	--
PAGURIDEA ZOEA	10	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 16 DATE: SEP 29 1970
LATITUDE: 70 16 0 NORTH LONGITUDE: 163 58 0 WEST
HAUL: 3 DEPTH: 12 METERS TIME: 19:14

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	150.0
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	1	-- - 60.00	--
CHRYSAORA MELANASTER	3	230.00-270.00	--
CYANEA CAPILLATA	7	60.00-160.00	--
CLIONE LIMACINA	3	-- - --	--
NEOMYSIS RAYII	2	28.00- 30.00	--
HYPERIA MEDUSARUM	1	-- - 14.00	--
THYSANOESSA INERMIS	9	12.00- 21.00	--
THYSANOESSA RASCHII	9	16.00- 21.00	--
PANDALUS GONIURUS	1	-- - --	7.5
BRACHYURA - ZOEA	7	-- - --	--
BRACHYURA - MEGALOPA	17	-- - --	--
PAGURIDEA ZOEA	16	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 16 DATE: SEP 29 1970
LATITUDE: 70 16 0 NORTH LONGITUDE: 163 58 0 WEST
HAUL: 4 DEPTH: 11 METERS TIME: 20:02

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	2.0
CUSPIDELLA MERTENSII	2	-- -120.00	--
AURELIA AURITA	3	-- - 60.00	--
CHRYSAORA MELANASTER	2	160.00-200.00	--
CYANEA CAPILLATA	7	50.00-200.00	--
CLIONE LIMACINA	6	-- - --	--
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 15.00	--
NEOMYSIS RAYII	2	-- - 27.00	--
APHERUSA GLACIALIS	3	8.00- 10.00	--
ERICTHONIUS TOLLI	1	-- - 10.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 12.00	--
THYSANOESSA INERMIS	6	14.00- 17.00	--
THYSANOESSA RASCHII	29	8.00- 25.00	--
PANDALUS GONIURUS	2	7.00- 10.00	--
EUALUS GAIMARDII	1	-- - 9.00	--
BRACHYURA - ZOEA	41	-- - --	--
BRACHYURA - MEGALOPA	163	-- - --	--
PAGURIDEA ZOEA	189	-- - --	--
PAGURIDEA GLAUCOTHOE	11	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 20 DATE: SEP 30 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 24 0 WEST
HAUL: 1 DEPTH: 12 METERS TIME: 18:10

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CUSPIDELLA MERTENSII	2	120.00-120.00	--
CHRYSAORA MELANASTER	5	220.00-225.00	--
CYANEA CAPILLATA	21	50.00-200.00	--
STOMPHIA SP.	1	-- - --	--
NEOMYSIS RAYII	6	26.00- 38.00	0.9
HYPERIA MEDUSARUM	1	-- - 19.00	0.4
GAMMARUS WILKITZKII	1	-- - 23.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 11.00	--
THYSANOESSA RASCHII	1	-- - 19.00	--
BRACHYURA - MEGALOPA	2	-- - --	--
PAGURIDEA ZOEA	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 20 DATE: SEP 30 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 24 0 WEST
HAUL: 2 DEPTH: 12 METERS TIME: 18:52

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CUSPIDELLA MERTENSII	1	-- - --	--
CHRYSAORA MELANASTER	4	240.00-300.00	--
CYANEA CAPILLATA	8	70.00-200.00	--
CLIONE LIMACINA	10	-- - --	--
BRACHYURA - MEGALOPA	30	-- - --	--
PAGURIDEA ZOEA	20	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 20 DATE: SEP 30 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 24 0 WEST
HAUL: 3 DEPTH: 12 METERS TIME: 19:43

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CHRYSAORA MELANASTER	4	240.00-280.00	--
CYANEA CAPILLATA	8	50.00-100.00	--
CLIONE LIMACINA	4	-- - --	--
BRACHYURA - MEGALOPA	5	-- - --	--
PAGURIDEA ZOEA	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 20 DATE: SEP 30 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 24 0 WEST
HAUL: 4 DEPTH: 12 METERS TIME: 20:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CUSPIDELLA MERTENSII	1	-- - --	--
CHRYSAORA MELANASTER	3	250.00-390.00	--
CYANEA CAPILLATA	3	60.00- 90.00	--
CLIONE LIMACINA	4	-- - --	--
MYSIS OCULATA/LITORALIS	2	16.00- 25.00	--
NEOMYSIS RAYII	4	29.00- 45.00	--
DIASTYLIS GLABRA	1	-- - 18.00	--
APHERUSA GLACIALIS	2	10.00- 12.00	--
GAMMARUS WILKITZKII	1	-- - 23.00	--
PRISCILLINA SP (? ARMATA)	3	6.00- 7.00	--
PSEUDALIBROTUS NANSENI	3	13.00- 16.00	--
PARAPHOXUS MILLERI	9	7.00- 9.00	--
THYSANOESSA INERMIS	1	-- - 18.00	--
THYSANOESSA RASCHII	9	15.00- 23.00	--
PANDALUS GONIURUS	2	6.00- 7.00	--
BRACHYURA - MEGALOPA	34	-- - --	--
PAGURIDEA ZOEA	13	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 22 DATE: OCT 1 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 25 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 18:04

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	150.0
CYANEA CAPILLATA	11	50.00-180.00	--
CLIONE LIMACINA	2	-- - --	--
NEOMYSIS RAYII	2	27.00- 30.00	--
PARAPHOXUS MILLERI	1	-- - 9.00	--
THYSANOESSA RASCHII	3	16.00- 17.00	--
BRACHYURA - MEGALOPA	4	-- - --	--
PAGURIDEA ZOEA	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 22 DATE: OCT 1 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 25 0 WEST
HAUL: 2 DEPTH: 11 METERS TIME: 18:48

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	150.0
CHRYSAORA MELANASTER	1	-- -320.00	--
CYANEA CAPILLATA	1	-- -110.00	--
CLIONE LIMACINA	3	-- - --	--
MYSIS OCULATA/LITORALIS	1	-- - 21.00	--
NEOMYSIS RAYII	1	-- - 28.00	--
THYSANOESSA INERMIS	3	19.00- 22.00	--
THYSANOESSA RASCHII	4	16.00- 17.00	--
BRACHYURA - MEGALOPA	5	-- - --	--
PAGURIDEA ZOEA	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 22 DATE: OCT 1 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 25 0 WEST
HAUL: 3 DEPTH: 11 METERS TIME: 20:20

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	100.0
CYANEA CAPILLATA	12	30.00-120.00	--
CLIONE LIMACINA	2	-- - --	--
NEOMYSIS RAYII	1	-- - 28.00	--
PSEUDALIBROTUS NANSENI	2	14.00- 15.00	--
THYSANOESSA INERMIS	2	-- - 21.00	--
THYSANOESSA RASCHII	3	7.00- 16.00	--
BRACHYURA - MEGALOPA	3	-- - --	--
PAGURIDEA ZOEA	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 22 DATE: OCT 1 1970
LATITUDE: 70 20 0 NORTH LONGITUDE: 163 25 0 WEST
HAUL: 4 DEPTH: 11 METERS TIME: 21:02

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CHRYSAORA MELANASTER	1	-- -290.00	--
CYANEA CAPILLATA	5	40.00-200.00	--
CLIONE LIMACINA	2	-- - --	--
HYPERIA MEDUSARUM	1	-- - 14.00	--
GAMMARUS WILKITZKII	1	-- - 20.00	--
PARAPHOXUS MILLERI	1	-- - 7.00	--
THYSANOESSA INERMIS	2	-- - 20.00	--
THYSANOESSA RASCHII	3	15.00- 19.00	--
BRACHYURA - ZOEA	2	-- - --	--
BRACHYURA - MEGALOPA	2	-- - --	--
PAGURIDEA ZOEA	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 25 DATE: OCT 2 1970
LATITUDE: 70 7 0 NORTH LONGITUDE: 163 14 0 WEST
HAUL: 1 DEPTH: 12 METERS TIME: 18:01

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	100.0
CHRYSAORA MELANASTER	1	-- -280.00	--
CYANEA CAPILLATA	1	-- - 80.00	--
CLIONE LIMACINA	1	-- - --	--
MYSIS OCULATA/LITORALIS	8	19.00- 30.00	--
NEOMYSIS RAYII	1	-- - 38.00	--
APHERUSA GLACIALIS	1	-- - 13.50	--
THYSANOESSA INERMIS	6	18.00- 23.00	--
THYSANOESSA RASCHII	3	20.00- 22.00	--
BRACHYURA - MEGALOPA	24	-- - --	--
PAGURIDEA ZOEA	12	-- - --	--
PAGURIDEA GLAUCOTHOE	5	-- - --	--

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      CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
                     IN THE SOUTHEASTERN CHUKCHI SEA
      NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

  STATION: 25       DATE:  OCT  2 1970
  LATITUDE:  70  7  0 NORTH   LONGITUDE: 163 14  0 WEST
  HAUL: 2       DEPTH:  11 METERS      TIME: 18:46

       SPECIES                      NBR. INDIVIDUALS    SIZE RANGE     VOLUME
    IDENTIFICATION                     PER SAMPLE          (MM)         (CC)

  AGLANTHA DIGITALE                         0           --  -  --      100.0
  CYANEA CAPILLATA                          4         30.00-200.00       --
  CLIONE LIMACINA                           1           --  -  --        --
  MYSIS OCULATA/LITORALIS                   9         18.00- 33.00      1.4
  APHERUSA GLACIALIS                        2           --  -  --        --
  GAMMARUS WILKITZKII                       1           --  - 17.00      --
  PSEUDALIBROTUS NANSENI                    1           --  - 18.00      --
  THYSANOESSA INERMIS                       4         16.00- 22.00       --
  THYSANOESSA RASCHII                      33         15.00- 22.00      1.4
  BRACHYURA - ZOEA                         13           --  -  --        --
  BRACHYURA - MEGALOPA                     65           --  -  --        --
  PAGURIDEA ZOEA                           23           --  -  --        --
  PAGURIDEA GLAUCOTHOE                     11           --  -  --        --
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      CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
                     IN THE SOUTHEASTERN CHUKCHI SEA
      NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

  STATION: 25       DATE:  OCT  2 1970
  LATITUDE:  70  7  0 NORTH   LONGITUDE: 163 14  0 WEST
  HAUL: 3       DEPTH:  12 METERS      TIME: 19:32

       SPECIES                      NBR. INDIVIDUALS    SIZE RANGE     VOLUME
    IDENTIFICATION                     PER SAMPLE          (MM)         (CC)

  AGLANTHA DIGITALE                         0           --  -  --       16.0
  AURELIA AURITA                            3         60.00-100.00       --
  CHRYSAORA MELANASTER                      2        160.00-220.00       --
  CLIONE LIMACINA                          11           --  -  --        --
  MYSIS OCULATA/LITORALIS                  14         18.00- 27.00       --
  APHERUSA GLACIALIS                        1           --  -  9.00      --
  PSEUDALIBROTUS NANSENI                    1           --  - 14.00      --
  THYSANOESSA INERMIS                       2         20.00- 21.00       --
  THYSANOESSA RASCHII                      23         15.00- 25.00       --
  BRACHYURA - ZOEA                         30           --  -  --        --
  BRACHYURA - MEGALOPA                    200           --  -  --        --
  PAGURIDEA ZOEA                           37           --  -  --        --
  PAGURIDEA GLAUCOTHOE                     18           --  -  --        --
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      CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
                     IN THE SOUTHEASTERN CHUKCHI SEA
      NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

  STATION: 25       DATE:  OCT  2 1970
  LATITUDE:  70  7  0 NORTH   LONGITUDE: 163 14  0 WEST
  HAUL: 4       DEPTH:  11 METERS      TIME: 20:36

       SPECIES                      NBR. INDIVIDUALS    SIZE RANGE     VOLUME
    IDENTIFICATION                     PER SAMPLE          (MM)         (CC)

  AGLANTHA DIGITALE                         0           --  -  --       50.0
  CUSPIDELLA MERTENSII                      1           --  -  --        --
  CHRYSAORA MELANASTER                      2        180.00-300.00       --
  CYANEA CAPILLATA                          6         40.00- 80.00       --
  CLIONE LIMACINA                           4           --  -  --        --
  MYSIS OCULATA/LITORALIS                   5         21.00- 32.00       --
  NEOMYSIS RAYII                            1           --  - 37.00      --
  APHERUSA GLACIALIS                        1           --  - 10.00      --
  THYSANOESSA INERMIS                      11         17.00- 24.00       --
  THYSANOESSA RASCHII                      27         15.00- 19.00       --
  BRACHYURA - MEGALOPA                    110           --  -  --        --
  PAGURIDEA ZOEA                           29           --  -  --        --
  PAGURIDEA GLAUCOTHOE                     11           --  -  --        --
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CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 30 DATE: OCT 4 1970
LATITUDE: 69 58 0 NORTH LONGITUDE: 164 7 0 WEST
HAUL: 1 DEPTH: 2 METERS TIME: 18:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	15.0
CYANEA CAPILLATA	3	70.00-200.00	--
CLIONE LIMACINA	4	-- - --	--
HYPERIA MEDUSARUM	1	-- - --	--
HIPPOMEDON PROPINQUUS	31	15.00- 20.00	--
PARAPHOXUS MILLERI	180	8.00- 10.00	--
THYSANOESSA INERMIS	1	-- - 20.00	--
THYSANOESSA RASCHII	1	-- - 15.00	--
BRACHYURA - MEGALOPA	4	-- - --	--
PAGURIDEA ZOEA	28	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 30 DATE: OCT 4 1970
LATITUDE: 69 58 0 NORTH LONGITUDE: 164 7 0 WEST
HAUL: 2 DEPTH: 5 METERS TIME: 19:04

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	1.0
AURELIA AURITA	1	-- - 90.00	--
CHRYSAORA MELANASTER	2	190.00-330.00	--
CYANEA CAPILLATA	9	30.00-130.00	--
CLIONE LIMACINA	7	-- - --	--
MYSIS OCULATA/LITORALIS	17	17.00- 27.00	--
HIPPOMEDON PROPINQUUS	36	16.00- 19.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	1	-- - 37.00	--
PARAPHOXUS MILLERI	38	6.00- 9.00	--
THYSANOESSA INERMIS	17	15.00- 23.00	--
THYSANOESSA RASCHII	20	17.00- 20.00	--
BRACHYURA - MEGALOPA	15	-- - --	--
PAGURIDEA ZOEA	7	-- - --	--
PAGURIDEA GLAUCOTHOE	8	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 30 DATE: OCT 4 1970
LATITUDE: 69 58 0 NORTH LONGITUDE: 164 7 0 WEST
HAUL: 3 DEPTH: 10 METERS TIME: 20:09

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	5.0
CUSPIDELLA MERTENSII	3	120.00-120.00	--
AURELIA AURITA	2	-- - --	--
CHRYSAORA MELANASTER	1	-- -230.00	--
CYANEA CAPILLATA	10	45.00-160.00	--
STOMPHIA SP.	1	-- - --	--
CLIONE LIMACINA	2	-- - --	--
MYSIS OCULATA/LITORALIS	46	10.00- 29.00	3.0
DIASTYLIS GLABRA	12	8.00- 30.00	1.2
AMPELISCA MACROCEPHALA	1	-- - 32.00	0.5
GAMMARUS WILKITZKII	1	-- - 16.00	--
PARAPHOXUS MILLERI	5	7.00- 9.00	--
SYRRHOE CRENULATA	1	-- - 11.00	--
THYSANOESSA INERMIS	3	20.00- 21.00	--
THYSANOESSA RASCHII	4	8.00- 17.00	--
PANDALUS GONIURUS	2	4.00- 5.00	--
ARGIS LAR	2	-- - 3.50	--
BRACHYURA - MEGALOPA	13	-- - --	0.1
PAGURIDEA ZOEA	35	-- - --	0.6
PAGURIDEA GLAUCOTHOE	24	-- - --	0.8

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 30 DATE: OCT 4 1970
LATITUDE: 69 58 0 NORTH LONGITUDE: 164 7 0 WEST
HAUL: 4 DEPTH: 13 METERS TIME: 20:45

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	6.0
CUSPIDELLA MERTENSII	3	-- - --	--
AURELIA AURITA	1	-- - --	--
CHRYSAORA MELANASTER	6	130.00-360.00	--
CYANEA CAPILLATA	19	50.00-190.00	--
STOMPHIA SP.	2	-- - --	--
ECHIURUS ECHIURUS ALASKANUS	2	-- - --	--
CLIONE LIMACINA	1	-- - 5.00	--
MYSIS OCULATA/LITORALIS	28	17.00- 34.00	--
DIASTYLIS GLABRA	16	16.00- 31.00	1.8
HYPERIA MEDUSARUM	2	16.00- 18.00	--
PONTOPOREA FEMORATA	2	13.00- 16.00	--
ANONYX NUGAX	1	-- - 13.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	21	9.00- 40.00	--
THYSANOESSA INERMIS	1	-- - 10.00	--
THYSANOESSA RASCHII	13	8.00- 18.00	--
PANDALUS GONIURUS	2	3.00- 7.00	--
ARGIS LAR	2	-- - 3.00	--
BRACHYURA - MEGALOPA	64	-- - --	--
PAGURIDEA ZOEA	50	-- - --	--
PAGURIDEA GLAUCOTHOE	22	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 30 DATE: OCT 4 1970
LATITUDE: 69 58 0 NORTH LONGITUDE: 164 7 0 WEST
HAUL: 5 DEPTH: 19 METERS TIME: 21:37

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	2.0
CUSPIDELLA MERTENSII	3	-- - --	--
AURELIA AURITA	1	-- -120.00	--
CHRYSAORA MELANASTER	2	290.00- --	--
CYANEA CAPILLATA	13	30.00-170.00	--
ECHIURUS ECHIURUS ALASKANUS	1	-- - 28.00	--
MYSIS OCULATA/LITORALIS	27	17.00- 29.00	--
DIASTYLIS GLABRA	6	20.00- 28.00	--
PROTOMEDIA STEPHENSENI	2	8.00- 10.00	--
RHACHOTROPSIS OCULATA	1	-- - 11.00	--
TRYPHOSA SP.	1	-- - 7.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	1	-- - 30.00	--
PARAPHOXUS MILLERI	2	9.00- 10.00	--
THYSANOESSA INERMIS	1	-- - 17.00	--
THYSANOESSA RASCHII	6	7.00- 21.00	--
PANDALUS GONIURUS	2	-- - 7.00	--
ARGIS LAR	1	-- - 3.00	--
BRACHYURA - MEGALOPA	39	-- - --	--
PAGURIDEA ZOEA	33	-- - --	--
PAGURIDEA GLAUCOTHOE	14	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 32 DATE: OCT 5 1970
LATITUDE: 69 48 0 NORTH LONGITUDE: 163 49 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 19:01

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	72.0
CUSPIDELLA MERTENSII	3	75.00-120.00	--
CYANEA CAPILLATA	5	50.00-150.00	--
MYSIS OCULATA/LITORALIS	1909	16.00- 33.00	133.0
NEOMYSIS RAYII	1	-- - 39.00	--
DIASTYLIS GLABRA	15	7.00- 28.00	0.3
DAJUS MYSIDIS	6	-- - --	--
ACANTHONOTOZOMA SERRATUM	1	-- - 7.00	--
AMPELISCA MACROCEPHALA	1	-- - 18.00	--
PROTOMEDIA STEPHENSENI	1	-- - 8.00	--
RHACHOTROPSIS ACULEATA	3	13.00- 27.00	0.8
ACANTHOSTEPHIA BEHRINGIENSIS	68	14.00- 38.00	8.4
MONOCULOIDES BOREALIS	5	10.00- 15.00	--
PARAPHOXUS MILLERI	3	-- - 8.00	--
SYRRHOE CRENULATA	2	10.00- 15.00	--
THYSANOESSA INERMIS	9	20.00- 21.00	0.9
PANDALUS GONIURUS	11	3.00- 15.00	14.2
EUALUS FABRICII	1	-- - --	4.0
EUALUS GAIMARDII	9	3.00- 7.00	1.2
ARGIS LAR	5	3.00- 18.00	5.2
HYAS COARCTATUS	151	-- - --	1.8
CHIONOECETES OPILIO	3	-- - --	--
BRACHYURA - MEGALOPA	8	-- - --	--
PAGURIDEA ZOEA	239	-- - --	5.6
PAGURIDEA GLAUCOTHOE	112	-- - --	3.3

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 32 DATE: OCT 5 1970
LATITUDE: 69 48 0 NORTH LONGITUDE: 163 49 0 WEST
HAUL: 2 DEPTH: 12 METERS TIME: 19:37

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	100.0
AURELIA AURITA	3	80.00-100.00	--
CHRYSAORA MELANASTER	4	60.00- 90.00	--
ECHIURUS ECHIURUS ALASKANUS	1	-- - 25.00	1.0
CLIONE LIMACINA	7	-- - --	--
MYSIS OCULATA/LITORALIS	700	20.00- 34.00	55.0
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 19.00	--
NEOMYSIS RAYII	5	16.00- 39.00	--
DIASTYLIS GLABRA	20	7.00- 27.00	0.3
AMPELISCA MACROCEPHALA	1	-- - 15.00	--
PROTOMEDIA STEPHENSENI	2	7.00- 9.00	--
RHACHOTROPSIS ACULEATA	5	13.00- 23.00	0.8
MELITA FORMOSA	1	-- - 16.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	78	11.00- 30.00	7.0
MONOCULOIDES BOREALIS	6	9.00- 11.00	--
PARAPHOXUS MILLERI	2	-- - 8.00	--
PLUESTES PANOPLA	1	-- - 17.00	--
SYRRHOE CRENULATA	2	12.00- 14.00	--
THYSANOESSA INERMIS	5	12.00- 24.00	0.3
THYSANOESSA RASCHII	2	-- - 13.00	--
PANDALUS GONIURUS	10	8.00- 14.00	11.0
EUALUS FABRICII	2	-- - 3.50	--
EUALUS GAIMARDII	4	5.00- 7.00	1.0
EUALUS MACILENTA	1	-- - 10.00	--
ARGIS LAR	9	3.00- 21.00	10.0
ARGIS CRASSA	1	-- - 10.50	1.2
BRACHYURA - MEGALOPA	100	-- - --	1.1
PAGURIDEA ZOEA	122	-- - --	2.8
PAGURIDEA GLAUCOTHOE	61	-- - --	1.6

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 32 DATE: OCT 5 1970
LATITUDE: 69 48 0 NORTH LONGITUDE: 163 49 0 WEST
HAUL: 3 DEPTH: 12 METERS TIME: 20:28

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	59.0
AURELIA AURITA	1	-- - --	--
CYANEA CAPILLATA	2	60.00-140.00	--
CLIONE LIMACINA	58	-- - --	--
MYSIS OCULATA/LITORALIS	976	17.00- 29.00	51.0
NEOMYSIS RAYII	5	28.00- 40.00	--
DIASTYLIS GLABRA	42	7.00- 30.00	1.5
DIASTYLIS SP (? LEPECHINI)	2	9.00- 13.00	--
LEUCON NASICA	1	-- - 13.00	--
AMPELISCA MACROCEPHALA	1	-- - 20.00	--
PROTOMEDIA STEPHENSENI	4	8.00- 11.00	--
RHACHOTROPSIS ACULEATA	2	23.00- 27.00	1.2
ANONYX LILLJEBORGI	1	-- - 10.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	40	13.00- 36.00	4.6
MONOCULOIDES BOREALIS	10	7.00- 11.00	--
MONOCULOIDES SP (? DIAMESUS)	2	8.00- 9.00	--
PLUESTES PANOPLA	2	-- - 14.00	--
THYSANOESSA RASCHII	5	9.00- 20.00	--
PANDALUS GONIURUS	11	6.50- 13.50	11.0
EUALUS GAIMARDII	5	-- - 6.00	1.2
ARGIS LAR	3	3.00- 13.00	11.0
CRANGON COMMUNIS	1	-- - 13.50	2.1
SCLEROCRANGON BOREAS	1	-- - 6.00	--
BRACHYURA - MEGALOPA	241	-- - --	5.0
PAGURIDEA ZOEA	104	-- - --	--
PAGURIDEA GLAUCOTHOE	74	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 32 DATE: OCT 5 1970
LATITUDE: 69 48 0 NORTH LONGITUDE: 163 49 0 WEST
HAUL: 1 DEPTH: 12 METERS TIME: 21:04

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	49.0
CUSPIDELLA MERTENSII	1	-- - --	--
CYANEA CAPILLATA	5	40.00-200.00	--
CLIONE LIMACINA	11	-- - --	--
MYSIS OCULATA/LITORALIS	539	17.00- 32.00	--
NEOMYSIS RAYII	1	-- - 35.00	--
DIASTYLIS GLABRA	42	7.00- 25.00	--
DIASTYLIS SP (? LEPECHINI)	1	-- - 12.00	--
DAJUS MYSIDIS	7	-- - --	--
ATYLUS BRUGGENI	1	-- - 23.00	--
PROTOMEDIA STEPHENSENI	2	8.00- 9.00	--
RHACHOTROPSIS ACULEATA	3	25.00- 36.00	--
MELITA FORMOSA	1	-- - 32.00	--
HIPPOMEDON PROPINQUUS	1	-- - 20.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	13	15.00- 18.00	--
MONOCULOIDES BOREALIS	8	9.00- 11.00	--
PARAPHOXUS MILLERI	4	-- - 7.00	--
SYRRHOE CRENULATA	1	-- - 12.00	--
THYSANOESSA INERMIS	2	17.00- 23.00	--
THYSANOESSA RASCHII	7	8.00- 20.00	--
PANDALUS GONIURUS	12	3.00- 15.00	14.0
EUALUS GAIMARDII	4	6.00- 7.00	1.4
ARGIS LAR	3	3.00- 18.00	7.0
BRACHYURA - MEGALOPA	243	-- - --	--
PAGURIDEA ZOEA	102	-- - --	--
PAGURIDEA GLAUCOTHOE	63	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 37 DATE: OCT 6 1970
LATITUDE: 70 7 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 1 DEPTH: 12 METERS TIME: 17:57

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CUSPIDELLA MERTENSII	1	-- -120.00	--
AURELIA AURITA	1	-- - 60.00	--
CHRYSAORA MELANASTER	1	-- -300.00	--
CYANEA CAPILLATA	8	50.00-170.00	--
CLIONE LIMACINA	1	-- - --	--
DIASTYLIS GLABRA	1	-- - 7.00	--
RHACHOTROPSIS ACULEATA	1	-- - 25.00	--
GAMMARUS WILKITZKII	1	-- - 15.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	1	-- - --	--
THYSANOESSA INERMIS	8	15.00- 19.00	--
THYSANOESSA RASCHII	9	8.00- 20.00	--
ARGIS LAR	1	-- - 3.00	--
BRACHYURA - MEGALOPA	135	-- - --	--
PAGURIDEA ZOEA	4	-- - --	--
PAGURIDEA GLAUCOTHOE	9	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 37 DATE: OCT 6 1970
LATITUDE: 70 7 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 2 DEPTH: 12 METERS TIME: 18:35

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CUSPIDELLA MERTENSII	3	-- - --	--
AURELIA AURITA	1	-- - 60.00	--
CYANEA CAPILLATA	15	60.00-270.00	--
STOMPHIA SP.	2	-- - --	--
EUSYLLIS (?) SP.	1	-- - --	--
GLYCINDE SP.	1	-- - --	--
MYSIS OCULATA/LITORALIS	1	-- - 30.00	--
HYPERIA GALBA	1	-- - 10.00	--
RHACHOTROPSIS ACULEATA	1	-- - 20.00	--
THYSANOESSA INERMIS	1	-- - 19.00	--
THYSANOESSA RASCHII	3	8.00- 20.00	--
BRACHYURA - MEGALOPA	[illegible]	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 37 DATE: OCT 6 1970
LATITUDE: 70 7 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 3 DEPTH: 12 METERS TIME: 19:15

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CHRYSAORA MELANASTER	1	-- -300.00	--
CYANEA CAPILLATA	7	50.00-140.00	--
AXIOTHELLA (?)	1	-- - --	--
CLIONE LIMACINA	1	-- - --	--
PSEUDALIBROTUS NANSENI	2	12.00- 18.00	0.3
THYSANOESSA INERMIS	2	18.00- 21.00	--
THYSANOESSA RASCHII	10	16.00- 22.00	--
BRACHYURA - ZOEA	1	-- - --	--
BRACHYURA - MEGALOPA	29	-- - --	--
PAGURIDEA ZOEA	6	-- - --	--
PAGURIDEA GLAUCOTHOE	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 37 DATE: OCT 6 1970
LATITUDE: 70 7 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 4 DEPTH: 12 METERS TIME: 19:56

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	11.0
CUSPIDELLA MERTENSII	1	-- -120.00	--
CYANEA CAPILLATA	6	30.00-150.00	--
CLIONE LIMACINA	12	-- - --	--
SAGITTA ELEGANS	2	17.00- 19.00	--
MYSIS OCULATA/LITORALIS	1	-- - 27.00	--
RHACHOTROPSIS ACULEATA	1	-- - --	--
GAMMARUS WILKITZKII	1	-- - 37.00	--
PSEUDALIBROTUS NANSENI	1	-- - 17.00	--
THYSANOESSA INERMIS	12	10.00- 24.00	1.5
THYSANOESSA RASCHII	47	12.00- 20.00	0.5
PANDALUS GONIURUS	6	2.50- 11.00	1.4
BRACHYURA - ZOEA	2	-- - --	--
BRACHYURA - MEGALOPA	129	-- - --	--
PAGURIDEA ZOEA	24	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 41 DATE: OCT 7 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 167 31 0 WEST
HAUL: 1 DEPTH: 19 METERS TIME: 18:22

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CUSPIDELLA MERTENSII	1	-- - --	--
CYANEA CAPILLATA	12	40.00-160.00	--
THYSANOESSA INERMIS	12	13.00- 22.00	0.9
THYSANOESSA RASCHII	28	7.00- 25.00	1.2
BRACHYURA - MEGALOPA	19	-- - --	--
PAGURIDEA ZOEA	14	-- - --	--
PAGURIDEA GLAUCOTHOE	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 41 DATE: OCT 7 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 167 31 0 WEST
HAUL: 2 DEPTH: 12 METERS TIME: 18:59

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CUSPIDELLA MERTENSII	1	-- - --	--
CHRYSAORA MELANASTER	1	-- -250.00	--
CYANEA CAPILLATA	10	40.00-120.00	--
CLIONE LIMACINA	2	-- - --	--
MYSIS POLARIS	1	-- - 19.00	--
NEOMYSIS RAYII	1	-- - 33.00	--
THYSANOESSA INERMIS	18	13.00- 24.00	--
THYSANOESSA RASCHII	31	15.00- 23.00	--
PANDALUS GONIURUS	3	-- - 3.00	--
EUALUS MACILENTA	1	-- - 7.00	--
BRACHYURA - MEGALOPA	13	-- - --	--
PAGURIDEA ZOEA	14	-- - --	--
PAGURIDEA GLAUCOTHOE	4	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 41 DATE: OCT 7 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 167 31 0 WEST
HAUL: 3 DEPTH: 20 METERS TIME: 19:35

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	20.0
CUSPIDELLA MERTENSII	5	-- - --	--
AURELIA AURITA	1	-- - --	--
CHRYSAORA MELANASTER	2	220.00-220.00	--
CYANEA CAPILLATA	13	30.00-160.00	--
NEOMYSIS RAYII	3	26.00- 34.00	--
HYPERIA MEDUSARUM	3	9.00- 11.00	--
THYSANOESSA INERMIS	2	-- - 20.00	--
THYSANOESSA RASCHII	9	17.00- 23.00	--
PANDALUS BOREALIS	1	-- - 11.00	1.1
PANDALUS GONIURUS	10	4.00- 11.50	2.8
BRACHYURA - MEGALOPA	5	-- - --	--
PAGURIDEA ZOEA	4	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 41 DATE: OCT 7 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 167 31 0 WEST
HAUL: 4 DEPTH: 10 METERS TIME: 20:14

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	1	-- - --	--
CHRYSAORA MELANASTER	6	230.00-300.00	--
CYANEA CAPILLATA	13	40.00-320.00	--
STOMPHIA SP.	1	-- - --	--
CLIONE LIMACINA	1	-- - --	--
NEOMYSIS RAYII	1	-- - --	--
PARATHEMISTO LIBELLULA	1	-- - 18.00	--
THYSANOESSA INERMIS	2	15.00- 20.00	--
THYSANOESSA RASCHII	2	-- - 24.00	--
PAGURIDEA ZOEA	2	-- - --	--
PAGURIDEA GLAUCOTHOE	2	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 45 DATE: OCT 8 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 168 38 0 WEST
HAUL: 1 DEPTH: 13 METERS TIME: 18:46

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	220.0
CUSPIDELLA MERTENSII	4	100.00-200.00	--
AURELIA AURITA	1	-- - 60.00	--
CHRYSAORA MELANASTER	3	150.00-200.00	--
CYANEA CAPILLATA	20	70.00-160.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 45 DATE: OCT 8 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 168 38 0 WEST
HAUL: 2 DEPTH: 0 METERS TIME: 19:21

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	30.0
CYANEA CAPILLATA	3	90.00-170.00	--
CLIONE LIMACINA	8	-- - --	--
NEOMYSIS RAYII	1	-- - 33.00	--
HYPERIA GALBA	1	-- - 12.00	--
GAMMARACANTHUS LORICATUS	1	-- - 13.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 11.00	--
THYSANOESSA INERMIS	152	9.00- 23.00	8.2
THYSANOESSA LONGIPES	1	-- - 15.00	--
THYSANOESSA RASCHII	143	8.00- 21.00	3.4
EUALUS GAIMARDII	1	-- - 9.00	--
BRACHYURA - MEGALOPA	368	-- - --	--
PAGURIDEA ZOEA	14	-- - --	--
PAGURIDEA GLAUCOTHOE	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 45 DATE: OCT 8 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 168 38 0 WEST
HAUL: 3 DEPTH: 9 METERS TIME: 20:23

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	100.0
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	2	260.00-300.00	--
CHRYSAORA MELANASTER	12	50.00-250.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 45 DATE: OCT 8 1970
LATITUDE: 69 57 0 NORTH LONGITUDE: 168 38 0 WEST
HAUL: 4 DEPTH: 18 METERS TIME: 20:58

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	150.0
CUSPIDELLA MERTENSII	8	100.00-150.00	--
CYANEA CAPILLATA	6	100.00-220.00	--
GLYCINDE SP.	1	-- - --	--
CHONE CINCTA (?)	1	-- - --	--
CLIONE LIMACINA	5	-- - --	--
MYSIS OCULATA/LITORALIS	8	20.00- 31.00	1.2
ACANTHOMYSIS SP.	1	-- - 25.00	--
NEOMYSIS RAYII	14	18.00- 39.00	2.6
DAJUS MYSIDIS	2	-- - --	--
HYPERIA GALBA	1	-- - 6.00	--
MONOCULOIDES BOREALIS	1	-- - 10.00	--
THYSANOESSA INERMIS	55	12.00- 25.00	4.0
THYSANOESSA RASCHII	428	8.00- 22.00	20.0
PANDALUS GONIURUS	39	2.00- 15.00	8.1
EUALUS GAIMARDII	3	5.00- 6.00	0.8
EUALUS STONEYI	9	5.00- 6.00	--
BRACHYURA - MEGALOPA	271	-- - --	--
PAGURIDEA ZOEA	69	-- - --	--
PAGURIDEA GLAUCOTHOE	174	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 51 DATE: OCT 9 1970
LATITUDE: 69 36 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 1 DEPTH: 13 METERS TIME: 18:14

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	150.0
CUSPIDELLA MERTENSII	5	-- -180.00	--
AURELIA AURITA	1	-- - 50.00	--
CHRYSAORA MELANASTER	6	230.00-260.00	--
CYANEA CAPILLATA	12	60.00-140.00	--
MYSIS OCULATA/LITORALIS	9	27.00- 32.00	1.0
ACANTHOMYSIS PSEUDOMACROPSIS	2	16.00- 17.00	--
NEOMYSIS RAYII	5	25.00- 37.00	--
THYSANOESSA INERMIS	15	12.00- 20.00	0.8
THYSANOESSA RASCHII	73	7.00- 20.00	3.0
PANDALUS GONIURUS	13	3.00- 10.00	1.2
EUALUS GAIMARDII	1	-- - 9.50	0.4
BRACHYURA - MEGALOPA	1	-- - --	--
PAGURIDEA ZOEA	7	-- - --	--
PAGURIDEA GLAUCOTHOE	20	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 51 DATE: OCT 9 1970
LATITUDE: 69 36 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 2 DEPTH: 2 METERS TIME: 18:48

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	10.0
CUSPIDELLA MERTENSII	2	180.00-180.00	--
AURELIA AURITA	1	-- -100.00	--
CYANEA CAPILLATA	5	40.00-220.00	--
CLIONE LIMACINA	1	-- - --	--
SAGITTA ELEGANS	1	-- - 20.00	--
MYSIS OCULATA/LITORALIS	19	20.00- 30.00	2.0
HYPERIA GALBA	1	-- - 10.00	--
PARATHEMISTO LIBELLULA	1	-- - 15.00	--
THYSANOESSA INERMIS	32	20.00- 23.00	3.2
THYSANOESSA RASCHII	24	9.00- 25.00	0.8
BRACHYURA - MEGALOPA	850	-- - --	--
PAGURIDEA ZOEA	5	-- - --	--
PAGURIDEA GLAUCOTHOE	21	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 51 DATE: OCT 9 1970
LATITUDE: 69 36 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 3 DEPTH: 7 METERS TIME: 19:48

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	12.0
CUSPIDELLA MERTENSII	2	-- - --	--
CHRYSAORA MELANASTER	1	-- -340.00	--
CALANUS FINMARCHICUS S.L.	4	-- - --	--
MYSIS OCULATA/LITORALIS	15	25.00- 28.00	2.1
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 19.00	--
NEOMYSIS RAYII	8	32.00- 39.00	2.0
THYSANOESSA INERMIS	104	9.00- 29.00	45.0
THYSANOESSA RASCHII	662	9.00- 24.00	11.0
PANDALUS GONIURUS	5	-- - 3.00	--
BRACHYURA - MEGALOPA	312	-- - --	--
PAGURIDEA ZOEA	46	-- - --	--
PAGURIDEA GLAUCOTHOE	37	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 51 DATE: OCT 9 1970
LATITUDE: 69 36 0 NORTH LONGITUDE: 167 36 0 WEST
HAUL: 4 DEPTH: 20 METERS TIME: 20:24

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	4	120.00-180.00	--
AURELIA AURITA	1	-- -100.00	--
CHRYSAORA MELANASTER	5	200.00-320.00	--
CYANEA CAPILLATA	22	30.00-180.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 56 DATE: OCT 10 1970
LATITUDE: 69 14 0 NORTH LONGITUDE: 166 53 0 WEST
HAUL: 1 DEPTH: 2 METERS TIME: 20:10

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	50	-- - --	--
CUSPIDELLA MERTENSII	1	-- -200.00	--
AURELIA AURITA	4	70.00-130.00	--
CYANEA CAPILLATA	4	50.00-160.00	--
CLIONE LIMACINA	16	-- - --	--
CALANUS FINMARCHICUS S.L.	1	-- - 2.00	--
MYSIS OCULATA/LITORALIS	194	19.00- 29.00	15.5
NEOMYSIS RAYII	19	33.00- 45.00	5.1
HYPERIA MEDUSARUM	2	1.00- 8.00	--
HYPEROCHE MEDUSARUM	1	-- - 7.00	--
THYSANOESSA INERMIS	5	18.00- 23.00	--
THYSANOESSA RASCHII	59	9.00- 27.00	2.6
BRACHYURA - MEGALOPA	9	-- - --	--
PAGURIDEA GLAUCOTHOE	21	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 56 DATE: OCT 10 1970
LATITUDE: 69 14 0 NORTH LONGITUDE: 166 53 0 WEST
HAUL: 2 DEPTH: 9 METERS TIME: 20:44

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	1.0
CUSPIDELLA MERTENSII	1	-- - --	--
AURELIA AURITA	1	-- -120.00	--
CHRYSAORA MELANASTER	2	200.00-450.00	--
CLIONE LIMACINA	1	-- - --	--
SAGITTA ELEGANS	41	17.00- 28.00	--
CALANUS CRISTATUS	1	-- - 11.00	--
MYSIS OCULATA/LITORALIS	63	20.00- 30.00	6.5
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 19.00	--
NEOMYSIS RAYII	14	29.00- 33.00	2.9
DAJUS MYSIDIS	1	-- - --	--
HYPERIA GALBA	2	-- - 3.00	--
PARATHEMISTO LIBELLULA	3	14.00- 17.00	--
THYSANOESSA INERMIS	1	-- - 20.00	--
THYSANOESSA RASCHII	21	12.00- 30.00	1.4
PANDALUS GONIURUS	23	3.50- 4.50	1.0
BRACHYURA - MEGALOPA	2	-- - --	--
PAGURIDEA ZOEA	19	-- - --	--
PAGURIDEA GLAUCOTHOE	8	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 56 DATE: OCT 10 1970
LATITUDE: 69 14 0 NORTH LONGITUDE: 166 53 0 WEST
HAUL: 3 DEPTH: 18 METERS TIME: 21:42

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	6	-- - --	--
CUSPIDELLA MERTENSII	1	-- -140.00	--
CHRYSAORA MELANASTER	8	210.00-320.00	--
CLIONE LIMACINA	6	10.00- 13.00	--
SAGITTA ELEGANS	18	14.00- 38.00	--
CALANUS CRISTATUS	1	-- - 9.00	--
MYSIS OCULATA/LITORALIS	16	19.00- 30.00	--
NEOMYSIS RAYII	5	31.00- 39.00	--
HYPERIA MEDUSARUM	1	-- - 12.00	--
HYPEROCHE MEDUSARUM	1	-- - 8.00	--
ACANTHONOTOZOMA SERRATUM	1	-- - 8.00	--
MAERA LOVENI	1	-- - 22.00	--
MELITA SP (? DESDICHADA)	1	-- - 13.00	--
THYSANOESSA RASCHII	3	10.00- 23.00	--
PANDALUS GONIURUS	21	3.00- 4.00	--
EUALUS GAIMARDII	1	-- - 5.00	--
EUALUS STONEYI	1	-- - 4.00	--
ARGIS LAR	29	3.00- 8.00	--
CRANGON DALLI	1	-- - 3.00	--
BRACHYURA - MEGALOPA	2	-- - 6.00	--
PAGURIDEA ZOEA	8	7.00- 9.00	--
PAGURIDEA GLAUCOTHOE	11	7.00- 8.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 56 DATE: OCT 10 1970
LATITUDE: 69 14 0 NORTH LONGITUDE: 166 53 0 WEST
HAUL: 4 DEPTH: 23 METERS TIME: 22:29

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	7.0
AURELIA AURITA	1	-- -100.00	--
CHRYSAORA MELANASTER	1	-- -300.00	--
LUMBRINEREIS FRAGILIS	1	-- - --	--
CLIONE LIMACINA	5	-- - --	--
SAGITTA ELEGANS	7	16.00- 28.00	--
EUCALANUS BUNGII	1	-- - 6.00	--
MYSIS OCULATA/LITORALIS	14	17.00- 32.00	--
ACANTHOMYSIS SP.	2	12.00- 13.00	--
NEOMYSIS RAYII	3	12.00- 38.00	--
MELITA SP (? DESDICHADA)	2	10.00- 11.00	--
THYSANOESSA INERMIS	3	20.00- 22.00	--
THYSANOESSA RASCHII	6	12.00- 20.00	--
PANDALUS GONIURUS	27	3.00- 4.00	--
EUALUS STONEYI	4	4.00- 5.00	--
ARGIS LAR	59	3.00- 14.00	--
BRACHYURA - MEGALOPA	6	-- - --	--
PAGURIDEA ZOEA	12	-- - --	--
PAGURIDEA GLAUCOTHOE	16	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 61 DATE: OCT 11 1970
LATITUDE: 69 5 0 NORTH LONGITUDE: 166 13 0 WEST
HAUL: 1 DEPTH: 13 METERS TIME: 18:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	4	-- - --	--
CHRYSAORA MELANASTER	3	250.00-300.00	--
CLIONE LIMACINA	2	-- - --	--
MYSIS OCULATA/LITORALIS	250	17.00- 33.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	5	12.00- 18.00	--
NEOMYSIS RAYII	33	10.00- 37.00	--
DIASTYLIS SP (? LEPECHINI)	2	11.00- 14.00	--
PARATHEMISTO LIBELLULA	1	-- - 15.00	--
ACANTHONOTOZOMA SERRATUM	1	-- - 12.00	--
ATYLUS BRUGGENI	2	19.00- 20.00	--
RHACHOTROPSIS ACULEATA	2	28.00- 29.00	--
MELITA FORMOSA	1	-- - 16.00	--
ANONYX LILLJEBORGI	1	-- - 12.00	--
THYSANOESSA RASCHII	2	17.00- 20.00	--
PANDALUS GONIURUS	364	3.00- 15.00	--
EUALUS FABRICII	1	-- - 7.00	--
EUALUS GAIMARDII	57	5.00- 9.00	--
EUALUS MACILENTA	1	-- - 7.00	--
LEBBEUS GROENLANDICUS	4	11.00- 12.00	--
ARGIS LAR	201	3.00- 17.00	--
CRANGON DALLI	2	9.00- 12.00	--
CRANGON SP. (? INTERMEDIA)	1	-- - 4.00	--
BRACHYURA - MEGALOPA	5	-- - --	--
PAGURIDEA ZOEA	30	-- - --	--
PAGURIDEA GLAUCOTHOE	16	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 61 DATE: OCT 11 1970
LATITUDE: 69 5 0 NORTH LONGITUDE: 166 13 0 WEST
HAUL: 2 DEPTH: 8 METERS TIME: 19:00

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CHRYSAORA MELANASTER	3	150.00-310.00	--
CYANEA CAPILLATA	1	-- -280.00	--
MYSIS OCULATA/LITORALIS	110	17.00- 27.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	5	16.00- 18.00	--
NEOMYSIS RAYII	217	10.00- 35.00	--
DIASTYLIS SP (? LEPECHINI)	1	-- - 8.00	--
PARATHEMISTO LIBELLULA	1	-- - 15.00	--
ATYLUS BRUGGENI	1	-- - 12.00	--
MAERA LOVENI	1	-- - 23.00	--
THYSANOESSA RASCHII	1	-- - 22.00	--
PANDALUS GONIURUS	953	3.00- 14.00	--
EUALUS GAIMARDII	1	-- - 7.00	--
LEBBEUS GROENLANDICUS	4	10.00- 12.00	--
ARGIS LAR	2	8.00- 10.00	--
ARGIS CRASSA	1	-- - 3.50	--
BRACHYURA - MEGALOPA	1	-- - --	--
PAGURIDEA ZOEA	56	-- - --	--
PAGURIDEA GLAUCOTHOE	30	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 61 DATE: OCT 11 1970
LATITUDE: 69 5 0 NORTH LONGITUDE: 166 13 0 WEST
HAUL: 3 DEPTH: 16 METERS TIME: 19:36

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CHRYSAORA MELANASTER	6	230.00-290.00	--
MYSIS OCULATA/LITORALIS	65	16.00- 20.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 16.00	--
ACANTHOMYSIS SP.	1	-- - 16.00	--
NEOMYSIS RAYII	85	27.00- 40.00	--
ACANTHONOTOZOMA SERRATUM	1	-- - 14.00	--
RHACHOTROPSIS ACULEATA	1	-- - 25.00	--
ANONYX NUGAX	1	-- - 22.00	--
HIPPOMEDON PROPINQUUS	1	-- - 15.00	--
MONOCULOIDES BOREALIS	1	-- - 9.00	--
PLUESTES PANOPLA	1	-- - 20.00	--
PANDALUS GONIURUS	1104	3.00- 15.00	--
EUALUS FABRICII	4	5.00- 13.00	--
EUALUS GAIMARDII	65	4.00- 10.00	--
EUALUS MACILENTA	1	-- - 5.00	--
LEBBEUS GROENLANDICUS	11	9.00- 16.00	--
ARGIS LAR	91	4.00- 15.00	--
CRANGON DALLI	2	9.00- 10.00	--
PAGURIDEA ZOEA	8	-- - --	--
PAGURIDEA GLAUCOTHOE	4	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 61 DATE: OCT 11 1970
LATITUDE: 69 5 0 NORTH LONGITUDE: 166 13 0 WEST
HAUL: 4 DEPTH: 23 METERS TIME: 20:15

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CHRYSAORA MELANASTER	4	170.00-360.00	--
CLIONE LIMACINA	2	-- - --	--
MYSIS OCULATA/LITORALIS	14	19.00- 37.00	--
PSEUDOMMA TRUNCATUM	10	31.00- 38.00	--
MELITA SP (? DESDICHADA)	7	9.00- 12.00	--
THYSANOESSA RASCHII	1	-- - 15.00	--
PANDALUS GONIURUS	118	3.00- 15.00	--
EUALUS FABRICII	3	5.00- 8.00	--
EUALUS GAIMARDII	44	4.00- 10.00	--
LEBBEUS GROENLANDICUS	1	-- - 7.00	--
ARGIS LAR	56	4.00- 16.00	--
PAGURIDEA ZOEA	6	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 65 DATE: OCT 12 1970
LATITUDE: 69 21 0 NORTH LONGITUDE: 166 45 0 WEST
HAUL: 1 DEPTH: 22 METERS TIME: 18:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	13.0
CUSPIDELLA MERTENSII	1	-- - --	--
AURELIA AURITA	1	-- -100.00	--
CHRYSAORA MELANASTER	5	100.00-240.00	--
CYANEA CAPILLATA	11	60.00-240.00	--
ANTINOE BADIA	2	-- - --	--
CLIONE LIMACINA	1	-- - 8.00	--
SAGITTA ELEGANS	3	18.00- 20.00	--
CALANUS FINMARCHICUS S.L.	3	3.00- 4.00	--
MYSIS OCULATA/LITORALIS	50	19.00- 31.00	--
NEOMYSIS RAYII	20	15.00- 36.00	--
HYPERIA MEDUSARUM	3	6.00- 12.00	--
AMPELISCA MACROCEPHALA	4	14.00- 16.00	--
BLYBIS GAIMARDII	5	12.00- 20.00	--
RHACHOTROPSIS ACULEATA	1	-- - 22.00	--
MELITA FORMOSA	2	25.00- 27.00	--
MELITA SP (? DESDICHADA)	1	-- - 14.00	--
MONOCULOIDES BOREALIS	1	-- - 9.00	--
THYSANOESSA INERMIS	14	17.00- 22.00	--
THYSANOESSA RASCHII	256	11.00- 21.00	--
PANDALUS GONIURUS	17	4.00- 15.00	--
EUALUS FABRICII	2	25.00- 28.00	--
EUALUS GAIMARDII	6	6.00- 10.00	--
ARGIS LAR	34	4.00- 21.00	--
BRACHYURA - MEGALOPA	3	-- - --	--
PAGURIDEA ZOEA	11	-- - --	--
PAGURIDEA GLAUCOTHOE	30	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 65 DATE: OCT 12 1970
LATITUDE: 69 21 0 NORTH LONGITUDE: 166 45 0 WEST
HAUL: 2 DEPTH: 16 METERS TIME: 19:02

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	8.0
CHRYSAORA MELANASTER	5	130.00-360.00	--
CYANEA CAPILLATA	3	70.00-160.00	--
STOMPHIA SP.	1	-- - --	--
LUMBRINEREIS SIMILABRIS	1	-- - --	--
SAGITTA ELEGANS	3	16.00- 17.00	--
CALANUS CRISTATUS	1	-- - 9.00	--
MYSIS OCULATA/LITORALIS	16	19.00- 30.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	2	-- - 19.00	--
ACANTHOMYSIS SP.	1	-- - 12.00	--
NEOMYSIS RAYII	22	13.00- 37.00	--
AMPELISCA MACROCEPHALA	1	-- - 11.00	--
MELITA SP (? DESDICHADA)	6	11.00- 14.00	--
MONOCULOIDES BOREALIS	1	-- - 10.00	--
SYRRHOE CRENULATA	1	-- - 13.00	--
THYSANOESSA INERMIS	16	20.00- 23.00	--
THYSANOESSA RASCHII	50	11.00- 23.00	--
PANDALUS GONIURUS	99	4.00- 18.00	--
EUALUS GAIMARDII	14	5.00- 11.00	--
ARGIS LAR	13	4.00- 12.00	--
BRACHYURA - MEGALOPA	4	-- - --	--
PAGURIDEA ZOEA	12	-- - --	--
PAGURIDEA GLAUCOTHOE	46	-- - --	--

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     CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
                         IN THE SOUTHEASTERN CHUKCHI SEA
     NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 65       DATE:  OCT 12 1970
LATITUDE:  69 21   0 NORTH    LONGITUDE: 166 45   0 WEST
HAUL: 3       DEPTH:   13 METERS       TIME: 19:40

       SPECIES                           NBR. INDIVIDUALS    SIZE RANGE     VOLUME
    IDENTIFICATION                          PER SAMPLE          (MM)         (CC)

AGLANTHA DIGITALE                                0          --  -  --       10.0
CUSPIDELLA MERTENSII                             1          --  -  --        --
AURELIA AURITA                                   1          --  - 70.00      --
CHRYSAORA MELANASTER                             6        170.00-380.00      --
CYANEA CAPILLATA                                 1          --  - 70.00      --
LUMBRINEREIS FRAGILIS                            1          --  -  --        --
CLIONE LIMACINA                                  3          --  -  --        --
BUCCINIUM SP (? ELATIUS)                         1          --  -  --        --
SAGITTA ELEGANS                                  2         17.00- 19.00      --
CALANUS FINMARCHICUS S.L.                        2          --  -  3.00      --
MYSIS OCULATA/LITORALIS                         22         16.00- 29.00      --
ACANTHOMYSIS PSEUDOMACROPSIS                     6         15.00- 19.00      --
NEOMYSIS RAYII                                 121         11.00- 38.00      --
PROTOMEDIA STEPHENSENI                           1          --  -  6.00      --
MELITA SP (? DESDICHADA)                         1          --  - 12.00      --
THYSANOESSA INERMIS                              8         18.00- 20.00      --
THYSANOESSA RASCHII                             25         11.00- 16.00      --
PANDALUS GONIURUS                              128          3.00- 16.00      --
EUALUS GAIMARDII                                 2          --  -  9.00      --
ARGIS LAR                                        2          --  -  3.00      --
BRACHYURA - MEGALOPA                             3          --  -  --        --
PAGURIDEA ZOEA                                  34          --  -  --        --
PAGURIDEA GLAUCOTHOE                            36          --  -  --        --
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     CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
                         IN THE SOUTHEASTERN CHUKCHI SEA
     NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 65       DATE:  OCT 12 1970
LATITUDE:  69 21   0 NORTH    LONGITUDE: 166 45   0 WEST
HAUL: 4       DEPTH:    8 METERS       TIME: 20:16

       SPECIES                           NBR. INDIVIDUALS    SIZE RANGE     VOLUME
    IDENTIFICATION                          PER SAMPLE          (MM)         (CC)

AGLANTHA DIGITALE                               50          --  -  --        7.0
CUSPIDELLA MERTENSII                             1          --  -  --        --
CHRYSAORA MELANASTER                             5        200.00-400.00      --
CYANEA CAPILLATA                                 3         80.00-160.00      --
CLIONE LIMACINA                                  5          --  -  --        --
MYSIS OCULATA/LITORALIS                          8         15.00- 27.00      --
ACANTHOMYSIS PSEUDOMACROPSIS                     5         16.00- 17.00      --
NEOMYSIS RAYII                                  26         30.00- 36.00      --
THYSANOESSA INERMIS                              7         19.00- 23.00      --
THYSANOESSA RASCHII                             22         11.00- 22.00      --
PANDALUS GONIURUS                               14          3.00- 13.00      --
EUALUS MACILENTA                                 1          --  -  8.00      --
ARGIS LAR                                        2          --  -  4.00      --
BRACHYURA - MEGALOPA                             1          --  -  --        --
PAGURIDEA ZOEA                                  19          --  -  --        --
PAGURIDEA GLAUCOTHOE                            16          --  -  --        --
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CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 70 DATE: OCT 13 1970
LATITUDE: 69 12 0 NORTH LONGITUDE: 167 38 0 WEST
HAUL: 1 DEPTH: 22 METERS TIME: 18:05

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	8.0
CUSPIDELLA MERTENSII	2	90.00- 90.00	--
CHRYSAORA MELANASTER	12	130.00-460.00	--
CYANEA CAPILLATA	4	50.00- 80.00	--
SAGITTA ELEGANS	4	15.00- 29.00	--
MYSIS OCULATA/LITORALIS	3	21.00- 26.00	--
HYPERIA MEDUSARUM	1	-- - 16.00	--
BLYBIS GAIMARDII	3	14.00- 15.00	--
MELITA FORMOSA	7	13.00- 25.00	--
MELITA SP (? DESDICHADA)	17	11.00- 14.00	--
THYSANOESSA INERMIS	15	19.00- 21.00	--
THYSANOESSA RASCHII	53	13.00- 21.00	--
PANDALUS GONIURUS	11	3.00- 17.00	--
EUALUS GAIMARDII	11	2.00- 11.00	--
ARGIS LAR	15	4.00- 23.00	--
PAGURIDEA ZOEA	5	-- - --	--
PAGURIDEA GLAUCOTHOE	9	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 70 DATE: OCT 13 1970
LATITUDE: 69 12 0 NORTH LONGITUDE: 167 38 0 WEST
HAUL: 2 DEPTH: 18 METERS TIME: 18:31

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	5.0
CUSPIDELLA MERTENSII	1	-- - --	--
AURELIA AURITA	3	70.00-100.00	--
CHRYSAORA MELANASTER	6	140.00-350.00	--
CLIONE LIMACINA	1	-- - 15.00	--
SAGITTA ELEGANS	5	16.00- 29.00	--
CALANUS CRISTATUS	1	-- - 8.00	--
MYSIS OCULATA/LITORALIS	2	22.00- 28.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 16.00	--
ACANTHOMYSIS SP.	1	-- - 11.00	--
NEOMYSIS RAYII	3	33.00- 36.00	--
LEUCON NASICA	1	-- - 10.00	--
HYPERIA GALBA	4	9.00- 12.00	--
BLYBIS GAIMARDII	2	11.00- 14.00	--
RHACHOTROPSIS ACULEATA	8	23.00- 32.00	--
MAERA LOVENI	2	25.00- 26.00	--
MELITA FORMOSA	1	-- - 22.00	--
MELITA SP (? DESDICHADA)	49	10.00- 14.00	--
PONTOPOREA FEMORATA	1	-- - 10.00	--
HIPPOMEDON PROPINQUUS	1	-- - 15.00	--
THYSANOESSA INERMIS	20	21.00- 23.00	--
THYSANOESSA LONGIPES	1	-- - 13.00	--
THYSANOESSA RASCHII	75	10.00- 23.00	--
PANDALUS BOREALIS	1	-- - 16.00	--
PANDALUS GONIURUS	26	3.00- 15.00	--
EUALUS GAIMARDII	9	5.00- 11.00	--
EUALUS MACILENTA	2	9.00- 10.00	--
EUALUS STONEYI	1	-- - 5.00	--
ARGIS LAR	17	3.00- 16.00	--
CRANGON COMMUNIS	1	-- - 5.00	--
BRACHYURA - MEGALOPA	3	-- - --	--
PAGURIDEA ZOEA	10	-- - --	--
PAGURIDEA GLAUCOTHOE	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 70 DATE: OCT 13 1970
LATITUDE: 69 12 0 NORTH LONGITUDE: 167 38 0 WEST
HAUL: 3 DEPTH: 13 METERS TIME: 19:21

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	10.0
CUSPIDELLA MERTENSII	1	-- - --	--
AURELIA AURITA	2	60.00- 70.00	--
CHRYSAORA MELANASTER	12	170.00-360.00	--
CYANEA CAPILLATA	2	70.00-140.00	--
ANTINOE SARSI	1	-- - --	--
CLIONE LIMACINA	8	-- - --	--
SAGITTA ELEGANS	20	16.00- 26.00	--
CALANUS CRISTATUS	1	-- - 9.00	--
MYSIS OCULATA/LITORALIS	2	28.00- 30.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - --	--
NEOMYSIS RAYII	2	32.00- 33.00	--
LEUCON NASICA	1	-- - 10.00	--
HYPERIA MEDUSARUM	1	-- - 10.00	--
MELITA SP (? DESDICHADA)	8	11.00- 14.00	--
PONTOPOREA FEMORATA	1	-- - 8.00	--
THYSANOESSA INERMIS	6	20.00- 22.00	--
THYSANOESSA RASCHII	20	10.00- 22.00	--
PANDALUS BOREALIS	1	-- - 12.00	--
PANDALUS GONIURUS	58	3.00- 16.00	--
EUALUS GAIMARDII	25	5.00- 10.00	--
EUALUS MACILENTA	20	5.00- 9.00	--
ARGIS LAR	11	4.00- 5.00	--
CRANGON COMMUNIS	1	-- - 6.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 70 DATE: OCT 13 1970
LATITUDE: 69 12 0 NORTH LONGITUDE: 167 38 0 WEST
HAUL: 4 DEPTH: 8 METERS TIME: 19:58

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	2	140.00-140.00	--
CHRYSAORA MELANASTER	14	100.00-270.00	--
ANTINOE BADIA	1	-- - --	--
CLIONE LIMACINA	13	-- - --	--
SAGITTA ELEGANS	4	20.00- 25.00	--
CALANUS CRISTATUS	3	8.00- 9.00	--
MYSIS OCULATA/LITORALIS	3	21.00- 23.00	--
NEOMYSIS RAYII	37	13.00- 36.00	--
EUDORELLA EMARGINATA	1	-- - --	--
LEUCON NASICA	1	-- - 9.00	--
THYSANOESSA INERMIS	22	12.00- 24.00	--
THYSANOESSA RASCHII	37	10.00- 22.00	--
PANDALUS GONIURUS	27	3.00- 17.00	--
EUALUS GAIMARDII	8	7.00- 11.00	--
EUALUS MACILENTA	9	4.00- 10.00	--
ARGIS LAR	2	4.00- 4.00	--
BRACHYURA - MEGALOPA	6	-- - --	--
PAGURIDEA ZOEA	15	-- - --	--
PAGURIDEA GLAUCOTHOE	10	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 74 DATE: OCT 14 1970
LATITUDE: 69 35 0 NORTH LONGITUDE: 164 29 0 WEST
HAUL: 1 DEPTH: 8 METERS TIME: 17:53

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	3.0
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	1	-- - --	--
CHRYSAORA MELANASTER	2	230.00-260.00	--
CYANEA CAPILLATA	12	30.00-200.00	--
CLIONE LIMACINA	1	-- - --	--
SAGITTA ELEGANS	2	-- - 26.00	--
MYSIS OCULATA/LITORALIS	115	16.00- 30.00	--
NEOMYSIS RAYII	3	25.00- 35.00	--
PROTOMEDIA STEPHENSENI	1	-- - 9.00	--
PSEUDALIBROTUS GLACIALIS	2	5.50- 12.00	--
PSEUDALIBROTUS NANSENI	1	-- - 7.00	--
PARAPHOXUS MILLERI	1	-- - 9.00	--
THYSANOESSA INERMIS	18	14.00- 21.00	--
THYSANOESSA LONGIPES	3	13.00- 15.00	--
THYSANOESSA RASCHII	10	6.00- 24.00	--
EUALUS SP.	1	-- - 2.00	--
BRACHYURA - MEGALOPA	2	-- - --	--
PAGURIDEA GLAUCOTHOE	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 74 DATE: OCT 14 1970
LATITUDE: 69 35 0 NORTH LONGITUDE: 164 29 0 WEST
HAUL: 2 DEPTH: 2 METERS TIME: 18:27

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	3.0
CUSPIDELLA MERTENSII	1	-- -120.00	--
AURELIA AURITA	2	30.00-110.00	--
CYANEA CAPILLATA	6	20.00-100.00	--
CLIONE LIMACINA	2	-- - --	--
MYSIS OCULATA/LITORALIS	18	16.00- 28.00	--
NEOMYSIS RAYII	2	23.00- 28.00	--
DIASTYLIS GLABRA	13	7.00- 8.00	--
PSEUDALIBROTUS GLACIALIS	1	-- - 13.00	--
PARAPHOXUS MILLERI	7	8.00- 9.00	--
THYSANOESSA INERMIS	42	15.00- 23.00	--
THYSANOESSA RASCHII	42	8.00- 21.00	--
HIPPOLYTIDAE SP.	1	-- - --	--
PAGURIDEA ZOEA	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 74 DATE: OCT 14 1970
LATITUDE: 69 35 0 NORTH LONGITUDE: 164 29 0 WEST
HAUL: 3 DEPTH: 13 METERS TIME: 19:11

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	0.5
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	2	70.00-120.00	--
CHRYSAORA MELANASTER	1	-- -170.00	--
CYANEA CAPILLATA	18	25.00-230.00	--
MYSIS OCULATA/LITORALIS	79	17.00- 31.00	--
NEOMYSIS RAYII	2	27.00- 34.00	--
DIASTYLIS GLABRA	3	-- - 7.00	--
HYPERIA MEDUSARUM	2	15.00- 18.00	--
GAMMARUS WILKITZKII	1	-- - 32.00	--
PARAPHOXUS MILLERI	1	-- - 9.00	--
THYSANOESSA INERMIS	3	10.00- 19.00	--
THYSANOESSA RASCHII	1	-- - 15.00	--
PANDALUS GONIURUS	5	7.00- 14.00	--
EUALUS FABRICII	1	-- - 5.00	--
EUALUS GAIMARDII	3	5.00- 8.00	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 74 DATE: OCT 14 1970
LATITUDE: 69 35 0 NORTH LONGITUDE: 164 29 0 WEST
HAUL: 4 DEPTH: 18 METERS TIME: 19:46

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	4	120.00-160.00	--
AURELIA AURITA	2	100.00-100.00	--
CHRYSAORA MELANASTER	2	300.00-370.00	--
CYANEA CAPILLATA	17	30.00-240.00	--
MYSIS OCULATA/LITORALIS	694	14.00- 33.00	--
NEOMYSIS RAYII	5	25.00- 37.00	--
DIASTYLIS GLABRA	17	19.00- 29.00	1.9
AMPELISCA MACROCEPHALA	1	-- - 29.00	--
PROTOMEDIA STEPHENSENI	1	-- - 9.00	--
ANONYX NUGAX	3	30.00- 35.00	--
PSEUDALIBROTUS GLACIALIS	3	12.00- 15.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	2	10.00- 19.00	--
MONOCULOIDES BOREALIS	8	10.00- 11.00	--
THYSANOESSA INERMIS	12	19.00- 23.00	--
THYSANOESSA LONGIPES	1	-- - 15.00	--
THYSANOESSA RASCHII	6	14.00- 19.00	--
PANDALUS GONIURUS	28	6.00- 14.00	--
EUALUS GAIMARDII	19	5.00- 11.00	--
ARGIS LAR	2	8.00- 13.00	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 80 DATE: OCT 15 1970
LATITUDE: 69 27 0 NORTH LONGITUDE: 164 43 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 18:44

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	4.0
AURELIA AURITA	2	100.00-120.00	--
CHRYSAORA MELANASTER	1	-- -300.00	--
CYANEA CAPILLATA	25	20.00-200.00	--
STOMPHIA SP.	3	-- - --	--
MYSIS OCULATA/LITORALIS	85	18.00- 31.00	--
NEOMYSIS RAYII	2	25.00- 27.00	--
DIASTYLIS GLABRA	2	26.00- 27.00	--
HYPERIA MEDUSARUM	1	-- - 12.00	--
GAMMARUS WILKITZKII	1	-- - 25.00	--
PSEUDALIBROTUS NANSENI	2	15.00- 18.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	1	-- - 29.00	--
THYSANOESSA INERMIS	25	15.00- 20.00	--
THYSANOESSA RASCHII	31	5.00- 20.00	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 80 DATE: OCT 15 1970
LATITUDE: 69 27 0 NORTH LONGITUDE: 164 43 0 WEST
HAUL: 2 DEPTH: 2 METERS TIME: 19:16

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	20	-- - --	--
AURELIA AURITA	2	30.00- 50.00	--
CHRYSAORA MELANASTER	2	280.00-300.00	--
CYANEA CAPILLATA	3	70.00-240.00	--
STOMPHIA SP.	6	-- - --	--
CLIONE LIMACINA	2	-- - --	--
MYSIS OCULATA/LITORALIS	210	12.00- 28.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 16.00	--
NEOMYSIS RAYII	11	23.00- 37.00	--
DIASTYLIS GLABRA	7	27.00- 28.00	--
HYPERIA MEDUSARUM	1	-- - 16.00	--
HIPPOMEDON PROPINQUUS	1	-- - 20.00	--
PSEUDALIBROTUS GLACIALIS	3	12.00- 13.00	--
THYSANOESSA INERMIS	230	10.00- 24.00	--
THYSANOESSA RASCHII	350	8.00- 24.00	--
BRACHYURA - MEGALOPA	1	-- - --	--
PAGURIDEA GLAUCOTHOE	1	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 80 DATE: OCT 15 1970
LATITUDE: 69 27 0 NORTH LONGITUDE: 164 43 0 WEST
HAUL: 3 DEPTH: 13 METERS TIME: 20:18

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	4	120.00-120.00	--
AURELIA AURITA	1	-- - 60.00	--
CHRYSAORA MELANASTER	5	230.00-460.00	--
CYANEA CAPILLATA	11	30.00-200.00	--
STOMPHIA SP.	1	-- - --	--
CLIONE LIMACINA	3	-- - --	--
MYSIS OCULATA/LITORALIS	750	-- - --	49.0
NEOMYSIS RAYII	2	-- - 25.00	--
DIASTYLIS GLABRA	1	-- - --	--
DAJUS MYSIDIS	7	-- - --	--
HYPEROCHE MEDUSARUM	1	-- - 8.00	--
AMPELISCA MACROCEPHALA	7	24.00- 30.00	3.5
PROTOMEDIA STEPHENSENI	1	-- - 8.00	--
GAMMARUS WILKITZKII	1	-- - --	--
PSEUDALIBROTUS GLACIALIS	2	11.00- 13.00	--
PSEUDALIBROTUS NANSENI	1	-- - 15.00	--
THYSANOESSA INERMIS	7	17.00- 27.00	--
THYSANOESSA RASCHII	15	10.00- 16.00	--
PANDALUS GONIURUS	4	8.00- 13.00	3.5
EUALUS GAIMARDII	3	6.00- 8.00	1.3
EUALUS SP.	1	-- - 2.50	--
ARGIS LAR	1	-- - 12.00	1.8
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 80 DATE: OCT 15 1970
LATITUDE: 69 27 0 NORTH LONGITUDE: 164 43 0 WEST
HAUL: 4 DEPTH: 22 METERS TIME: 20:55

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
CUSPIDELLA MERTENSII	8	90.00-140.00	--
AURELIA AURITA	3	60.00-100.00	--
CHRYSAORA MELANASTER	1	-- -150.00	--
CYANEA CAPILLATA	51	50.00-240.00	--
STOMPHIA SP.	22	-- - --	8.0
PHASCOLOSOMA	2	-- - --	--
MYSIS OCULATA/LITORALIS	842	21.00- 42.00	90.0
ACANTHOMYSIS PSEUDOMACROPSIS	1	-- - 18.00	--
NEOMYSIS RAYII	1	-- - 33.00	--
DIASTYLIS GLABRA	97	11.00- 32.00	--
DIASTYLIS SP (? LEPECHINI)	1	-- - 12.00	--
HYPERIA GALBA	1	-- - 5.00	--
HYPERIA MEDUSARUM	4	10.00- 20.00	0.8
AMPELISCA MACROCEPHALA	42	28.00- 32.00	14.0
BLYBIS GAIMARDII	1	-- - 22.00	--
ATYLUS BRUGGENI	1	-- - 14.00	--
PROTOMEDIA STEPHENSENI	9	7.00- 12.00	--
RHACHOTROPSIS ACULEATA	2	20.00- 25.00	1.0
GAMMARUS ZADDACHI	1	-- - 15.00	--
MELITA FORMOSA	1	-- - 15.00	--
ERICTHONIUS TOLLI	2	10.00- 12.00	--
ISCHYROCERUS LATIPES	1	-- - 12.00	--
ANONYX NUGAX	66	8.00- 35.00	50.0
PSEUDALIBROTUS GLACIALIS	2	11.00- 12.00	--
PSEUDALIBROTUS NANSENI	1	-- - 15.00	--
ACANTHOSTEPHIA BEHRINGIENSIS	15	15.00- 40.00	10.0
MONOCULOIDES BOREALIS	5	10.00- 11.00	--
THYSANOESSA INERMIS	10	18.00- 24.00	0.5
THYSANOESSA LONGIPES	5	15.00- 17.00	--
PANDALUS GONIURUS	44	7.00- 16.50	27.0
EUALUS FABRICII	1	-- - 9.00	1.0
EUALUS GAIMARDII	139	4.50- 10.50	57.0
ARGIS LAR	138	3.00- 20.00	126.0
CHIONOECETES OPILIO	1	-- - 25.00	--
BRACHYURA - ZOEA	2	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 88 DATE: OCT 16 1970
LATITUDE: 68 55 0 NORTH LONGITUDE: 166 47 0 WEST
HAUL: 1 DEPTH: 11 METERS TIME: 19:47

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AURELIA AURITA	1	-- -100.00	--
CYANEA CAPILLATA	1	-- -150.00	--
STOMPHIA SP.	1	-- - --	--
MYSIS OCULATA/LITORALIS	1870	20.00- 40.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	35	7.00- 18.00	0.7
NEOMYSIS RAYII	122	10.00- 37.00	17.0
DIASTYLIS GLABRA	27	10.00- 30.00	3.6
DAJUS MYSIDIS	12	-- - --	--
HYPERIA MEDUSARUM	1	-- - 15.00	0.2
AMPELISCA MACROCEPHALA	1	-- - 26.00	--
ANONYX NUGAX	8	15.00- 35.00	6.0
PSEUDALIBROTUS NANSENI	1	-- - 17.00	--
THYSANOESSA INERMIS	301	16.00- 26.00	28.0
THYSANOESSA RASCHII	210	9.00- 28.00	9.0
PANDALUS GONIURUS	18	2.50- 9.00	1.8
EUALUS GAIMARDII	4	5.00- 8.00	1.0
ARGIS LAR	3	4.00- 9.00	1.1
BRACHYURA - MEGALOPA	5	-- - --	--
PAGURIDEA ZOEA	14	-- - --	--
PAGURIDEA GLAUCOTHOE	79	-- - --	1.8

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 88 DATE: OCT 16 1970
LATITUDE: 68 55 0 NORTH LONGITUDE: 166 47 0 WEST
HAUL: 2 DEPTH: 2 METERS TIME: 20:22

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	20	-- - --	--
AURELIA AURITA	1	-- - 60.00	--
CYANEA CAPILLATA	1	-- -100.00	--
CLIONE LIMACINA	1	-- - --	--
MYSIS OCULATA/LITORALIS	1533	17.00- 30.00	100.0
ACANTHOMYSIS PSEUDOMACROPSIS	12	9.00- 17.00	--
NEOMYSIS RAYII	30	11.00- 32.00	--
DIASTYLIS GLABRA	1	-- - 25.00	--
DAJUS MYSIDIS	1	-- - --	--
ANONYX NUGAX	2	-- - 35.00	1.8
THYSANOESSA INERMIS	19	16.00- 20.00	0.8
THYSANOESSA RASCHII	30	8.00- 18.00	1.9
PANDALUS GONIURUS	1	-- - 9.00	--
EUALUS SP.	1	-- - --	--
BRACHYURA - MEGALOPA	3	-- - --	--
PAGURIDEA ZOEA	1	-- - --	--
PAGURIDEA GLAUCOTHOE	12	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA

NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 88 DATE: OCT 16 1970
LATITUDE: 68 55 0 NORTH LONGITUDE: 166 47 0 WEST
HAUL: 3 DEPTH: 24 METERS TIME: 21:25

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	14.0
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	2	50.00-140.00	--
CYANEA CAPILLATA	3	30.00-170.00	--
CLIONE LIMACINA	3	-- - --	--
MYSIS OCULATA/LITORALIS	242	17.00- 33.00	20.0
ACANTHOMYSIS PSEUDOMACROPSIS	11	17.00- 19.00	0.2
ACANTHOMYSIS SP.	2	10.00- 14.00	--
NEOMYSIS RAYII	238	9.00- 40.00	58.0
PSEUDOMMA TRUNCATUM	1	-- - 9.00	--
DAJUS MYSIDIS	20	-- - --	--
PARATHEMISTO LIBELLULA	1	-- - 15.00	--
RHACHOTROPSIS ACULEATA	2	15.00- 24.00	0.4
MELITA SP (? DESDICHADA)	7	13.00- 15.00	--
THYSANOESSA INERMIS	24	19.00- 21.00	2.3
THYSANOESSA LONGIPES	1	-- - 16.00	--
THYSANOESSA RASCHII	30	9.00- 20.00	1.2
PANDALUS GONIURUS	16	3.00- 11.50	4.8
EUALUS GAIMARDII	58	6.00- 9.00	14.0
EUALUS STONEYI	2	-- - 5.00	--
EUALUS SP.	2	-- - 2.00	--
ARGIS LAR	3	4.00- 4.50	--
BRACHYURA - MEGALOPA	9	-- - --	--
PAGURIDEA ZOEA	150	-- - --	--
PAGURIDEA GLAUCOTHOE	113	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 88 DATE: OCT 16 1970
LATITUDE: 68 55 0 NORTH LONGITUDE: 166 47 0 WEST
HAUL: 4 DEPTH: 40 METERS TIME: 22:05

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	336.0
CUSPIDELLA MERTENSII	1	-- -140.00	--
AURELIA AURITA	1	-- - 80.00	--
CYANEA CAPILLATA	23	60.00-230.00	--
NEPTHYS PARADOXA (?)	2	-- - --	--
PHASCOLOSOMA	1	-- - --	--
LUMBRINEREIS SIMILABRIS	1	-- - --	--
AXIOTHELLA (?)	1	-- - --	--
MARGARITES SP.	1	-- - --	--
NATICA CLAUSA	1	-- - --	--
NUCULA TENUIS	1	-- - --	--
OPHIUROIDEA	1	-- - --	--
SAGITTA ELEGANS	1	-- - --	--
MYSIS OCULATA/LITORALIS	442	12.00- 37.00	50.0
ACANTHOMYSIS PSEUDOMACROPSIS	4	-- - --	--
ACANTHOMYSIS SP.	5	9.00- 15.00	--
NEOMYSIS RAYII	91	8.00- 38.00	20.0
PSEUDOMMA TRUNCATUM	1	-- - 9.00	--
EUDORELLA EMARGINATA	1	-- - 10.50	--
DAJUS MYSIDIS	4	-- - --	--
HYPERIA GALBA	1	-- - 14.00	--
HYPERIA MEDUSARUM	2	10.00- 18.00	--
ACANTHONOTOZOMA SERRATUM	1	-- - 7.00	--
PROTOMEDIA STEPHENSENI	2	7.00- 7.00	--
RHACHOTROPSIS ACULEATA	1	-- - 15.00	--
MELITA FORMOSA	4	12.00- 23.00	--
MELITA SP (? DESDICHADA)	7	10.00- 14.00	--
ANONYX NUGAX	2	14.00- 26.00	--
MONOCULOIDES BOREALIS	2	8.00- 9.00	--
THYSANOESSA INERMIS	5	22.00- 23.00	--
THYSANOESSA RASCHII	11	8.50- 22.00	--
PANDALUS GONIURUS	8	8.00- 14.00	9.0
EUALUS FABRICII	9	3.00- 7.00	0.6
EUALUS GAIMARDII	20	5.00- 9.00	7.0
EUALUS STONEYI	1	-- - 5.00	--
ARGIS LAR	70	3.00- 17.00	23.0
CRANGON DALLI	1	-- - 6.50	0.2
PAGURUS TRIGONOCHEIRUS	2	-- - --	--
PAGURIDEA ZOEA	70	-- - --	1.9
PAGURIDEA GLAUCOTHOE	104	-- - --	3.0

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 92 DATE: OCT 17 1970
LATITUDE: 68 36 0 NORTH LONGITUDE: 167 41 0 WEST
HAUL: 1 DEPTH: 13 METERS TIME: 18:03

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	50.0
CHRYSAORA MELANASTER	5	240.00-400.00	--
CYANEA CAPILLATA	1	-- -200.00	--
STOMPHIA SP.	2	-- - --	--
MYSIS OCULATA/LITORALIS	2	17.00- 30.00	--
NEOMYSIS RAYII	5	33.00- 34.00	--
DIASTYLIS GLABRA	1	-- - 16.00	--
THYSANOESSA RASCHII	5	10.00- 22.00	--
PANDALUS GONIURUS	2	8.00- 9.00	1.0

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 92 DATE: OCT 17 1970
LATITUDE: 68 36 0 NORTH LONGITUDE: 167 41 0 WEST
HAUL: 2 DEPTH: 2 METERS TIME: 18:37

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	6.0
AURELIA AURITA	2	110.00- --	--
CHRYSAORA MELANASTER	2	170.00-240.00	--
CYANEA CAPILLATA	3	50.00-160.00	--
CLIONE LIMACINA	7	-- - --	--
SAGITTA ELEGANS	2	12.00- 30.00	--
MYSIS OCULATA/LITORALIS	16	17.00- 26.00	--
ACANTHOMYSIS PSEUDOMACROPSIS	4	10.00- 17.00	--
NEOMYSIS RAYII	2	-- - 33.00	--
HYPERIA MEDUSARUM	1	-- - 16.00	--
HYPEROCHE MEDUSARUM	1	-- - 9.00	--
THYSANOESSA INERMIS	24	10.00- 25.00	--
THYSANOESSA RASCHII	331	14.00- 19.00	--
ARGIS LAR	1	-- - 4.00	--
PAGURIDEA ZOEA	4	-- - --	--
PAGURIDEA GLAUCOTHOE	5	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 92 DATE: OCT 17 1970
LATITUDE: 68 36 0 NORTH LONGITUDE: 167 41 0 WEST
HAUL: 3 DEPTH: 33 METERS TIME: 19:35

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	0	-- - --	102.0
AURELIA AURITA	1	-- - --	--
CHRYSAORA MELANASTER	6	160.00-470.00	--
CLIONE LIMACINA	3	-- - --	--
SAGITTA ELEGANS	1	-- - 22.00	--
MYSIS OCULATA/LITORALIS	1	-- - 24.00	--
NEOMYSIS RAYII	5	30.00- 36.00	1.4
HYPERIA GALBA	1	-- - 9.00	--
RHACHOTROPSIS OCULATA	1	-- - 13.00	--
THYSANOESSA RASCHII	6	12.00- 20.00	--
PANDALUS GONIURUS	1	-- - 4.00	--
EUALUS GAIMARDII	12	5.00- 10.00	6.0
EUALUS STONEYI	4	4.00- 6.00	0.3
ARGIS LAR	14	4.00- 16.00	6.0
CRANGON DALLI	1	-- - 6.00	--
BRACHYURA - MEGALOPA	2	-- - --	--
PAGURIDEA ZOEA	2	-- - --	--
PAGURIDEA GLAUCOTHOE	3	-- - --	--

CATCHES OF INVERTEBRATES BY 1.8 METER ISAACS-KIDD MID WATER TRAWL
IN THE SOUTHEASTERN CHUKCHI SEA
NUMBER, SIZE-RANGE, AND DISPLACEMENT VOLUME FOR EACH HALF-HOUR TOW

STATION: 92 DATE: OCT 17 1970
LATITUDE: 68 36 0 NORTH LONGITUDE: 167 41 0 WEST
HAUL: 4 DEPTH: 17 METERS TIME: 20:14

SPECIES IDENTIFICATION	NBR. INDIVIDUALS PER SAMPLE	SIZE RANGE (MM)	VOLUME (CC)
AGLANTHA DIGITALE	3	-- - --	--
CHRYSAORA MELANASTER	5	260.00-420.00	--
CYANEA CAPILLATA	2	90.00- 90.00	--
MYSIS OCULATA/LITORALIS	1	-- - 20.00	--
NEOMYSIS RAYII	4	33.00- 45.00	1.2
THYSANOESSA INERMIS	1	-- - 20.00	--
THYSANOESSA RASCHII	4	12.00- 18.00	--
PANDALUS GONIURUS	3	9.00- 11.00	2.6
EUALUS GAIMARDII	1	-- - 5.00	--
PAGURIDEA GLAUCOTHOE	1	-- - --	--

S. GOVERNMENT PRINTING OFFICE: 1977—797-266/16 REGION 10

NOAA Technical Report NMFS SSRF-711

A List of the Marine Mammals of the World (Third Edition)

Dale W. Rice

April 1977

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Robert M. White, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

For Sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 Stock No. 003-020-00134-3

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mbers in parentheses indicate number of species in each family.

A List of the Marine Mammals of the World[1]

DALE W. RICE[2]

ABSTRACT

Listed are the 116 species of Recent marine mammals, including freshwater species of the predominantly marine groups. The number of species are: Order Carnivora, 36 (polar bear, sea otter, and 34 pinnipeds); Order Sirenia, 5; Order Mysticeti, 10; and Order Odontoceti, 65. The geographic distribution of each species is indicated.

INTRODUCTION

ed here are the living and recently extinct marine nals of the world: the sea otter, polar bear, pin- , sirenians, and cetaceans. Living freshwater pin- , sirenians, and cetaceans are included.

mpts to classify marine mammals are difficult se they are poorly known. Some live on the high nd others on remote oceanic islands or among polar lds. Some sirenians and smaller cetaceans live in al waters seldom visited by mammalogists. The ses of marine mammals are large, greasy, bloody, ten putrefied before they are brought to the atten- biologists. They are difficult and expensive to col- d to preserve for study. As a result, some kinds are ented in scientific collections by only a few skulls heir external appearance is poorly known. Thus, t of the marine mammals, especially of the smaller ans, can be regarded only as provisional.

seals have usually been separated from the ter- l carnivores as Order (or Suborder) Pinnipedia. It clear, however, that the pinnipeds had a common with the weasel, racoon, dog, and bear families, gether they constitute one of the two main sub- ns of living carnivores (Mitchell and Tedford

cetaceans have usually been regarded as com- g a single order, but their origins are obscure, and it estionable whether they are monophyletic. The oceti (toothed whales) and the Mysticeti (baleen s) have been separate since at least the late e, and all authors have recognized them as valid t either the subordinal or ordinal level. The dif- es between the two groups are as great as those en some of the universally recognized orders of nals (Rice, in Anderson and Jones 1967). Therefore w Kleinenberg (1958) and some other authors in g them as separate orders.

he Order Odontoceti, the species of the genera *ista, Sousa, Sotalia,* and *Tursiops* herein recognized as valid have been changed to conform to the "List of Smaller Cetaceans Recognized," agreed upon at the special meeting on smaller cetaceans held by the Scientific Committee of the International Whaling Commission (1975). The present list now agrees with the IWC Scientific Committee's list. It appears that the specific classification of the Odontoceti is approaching a consensus. Future studies may indicate that certain closely related allopatric forms now listed as separate species should be regarded as conspecific; such cases are noted in the text. Recent studies on some species of small cetaceans (e.g., *Stenella longirostris* and *S. attenuata*) have revealed considerable geographic variation. Most species of cetaceans are still too poorly known for subspecies to be defined, but I have listed the proposed subspecies that appear to be valid.

In the few cases where the nomenclature or classification in the present list differs from that in the working list compiled by the U.S. Marine Mammal Commission (1976), the reasons are explained in the text or in the references cited therein.

The following names are senior synonyms of names used in this list; according to Article 23b of the International Code for Zoological Nomenclature (International Trust for Zoological Nomenclature 1964), these names are nomina oblita and cannot replace the names herein employed:

Stenorhinchus E. Geoffroy St.-Hilaire and F. Cuvier, 1826 (= *Hydrurga* Gistel, 1848)
Susu Lesson, 1828 (= *Platanista* Wagler, 1830)
Nodus Wagler, 1830 (= *Mesoplodon* Gervais, 1850)
Tursiops nesarnack (Lacépède, 1804) [= *T. truncatus* (Montagu, 1821)]
Phoca vitulina stejnegeri Allen, 1902 (= *Phoca vitulina kurilensis* Inukai, 1942)
Hyperoodontidae Gray, 1846 (= Ziphiidae Gray, 1865).

Synonyms commonly used in recent literature are listed on page 12; see Scheffer (1958) for synonymy of pinnipeds and Hershkovitz (1966) for synonymy of cetaceans.

Vernacular names are included for most species. In selecting vernacular names, I have been guided, but not bound, by the principles adopted by the American Fisheries Society's Committee on Names of Fishes

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sion of two earlier lists under the same title (Scheffer and Rice e and Scheffer 1968).

e Mammal Division Northwest Fisheries Center, National Fisheries Service, NOAA, Seattle, WA 98115.

(Bailey et al. 1970) and the American Ornithologists' Union's Committee on Classification and Nomenclature (1973). Many small cetaceans lack distinctive vernacular names; hence some names listed here are "book" names. I am not attempting to "standardize" vernacular names—the time is not ripe for that. I hope that field workers will record or invent more appropriate names where needed.

The report deals only with the Recent marine mammals. Readers interested in fossil forms are referred to the following publications: Winge (1921); Miller (1923); Kellogg (1928, 1936); Slijper (1936); Simpson (1945); Piveteau (1958, 1961); Reinhart (1959); Matthes (1962); King (1964); and Romer (1966).

Order CARNIVORA

The living carnivores comprise two superfamilies—Feloidea (mongooses, cats, hyenas, etc.) and Canoidea (dogs, bears, raccoons, weasels, seals, etc.) (Mitchell and Tedford 1973). Only the latter superfamily includes marine species.

Family URSIDAE

There are five living genera of bears and giant pandas (Hendey 1972), but only one contains a marine species.

Genus URSUS Linnaeus, 1758

Only one of the four species of this genus is marine.

Ursus maritimus Phipps, 1774 (polar bear).
Ice-covered regions of Arctic Ocean and contiguous seas, and adjacent coasts and islands.

Family ODOBENIDAE

Mitchell (1975) regarded the walruses as a subfamily of the Otariidae, whereas Repenning (1975) maintained them as a separate family. Pending a consensus, I follow most previous authors in listing them as a separate family.

Genus ODOBENUS Brisson, 1762

Odobenus rosmarus (Linnaeus, 1758) (walrus).
Shallow waters near ice in the Arctic Ocean and adjacent seas. Three subspecies are currently recognized: *O. r. rosmarus* in the Atlantic-Arctic; *O. r. divergens* (Illiger, 1815), in the Pacific-Arctic; and *O. r. laptevi* Chapskii, 1940, in the Laptev Sea. The Atlantic subspecies contains two breeding groups, one from the Kara Sea to eastern Greenland and another from western Greenland and eastern Canada. The latter population may be subspecifically distinct. There are late Pleistocene to prehistoric records as far south as California, Michigan, North Carolina, and France (Repenning, pers. commun.).

Family OTARIIDAE

Genus PHOCARCTOS Peters, 1866

Phocarctos hookeri (Gray, 1844) (Auckland sea
New Zealand sea lion).
Subantarctic islands south of New Zealand; b
regularly only at Carnley Harbor and Enderl
land in the Auckland Islands, rarely at Cam
Island. Hauls out on Snares Islands, Macquai
land, and South Island, N.Z. Occurred on Nor
land, N.Z., less than 1,000 yr ago. For discuss
the relationships of *Phocarctos*, *Neophoca*,
Zalophus see King (1960).

Genus OTARIA Péron, 1816

Otaria flavescens (Shaw, 1800) (South America
lion).
Coastal waters from Recife das Tôrres, Brazil
Zorritos, Peru, southward to Strait of Magella
Falkland Islands. Some authors have use
specific name *byronia* de Blainville, 1820, b
Hershkovitz pointed out (pers. commun.) tha
type of *flavescens* was a tangible specimen pres
in the old Leverian museum. It was adequatel
cribed and figured, is perfectly identifiable, ar
a valid type locality. Its name has priority,
and currency."

Genus ZALOPHUS Gill, 1866

Zalophus californianus (Lesson, 1828) (black sea
California, Japanese, and Galapagos sea lions)
One subspecies, *Z. c. californianus*, breeds fro
Miguel Island, Calif., south to Punta Entrada
California, and on islands in the upper G
California, ranging at sea north to Vancou
land, south to Cabo San Lucas and Mazatlán.
ond subspecies of unconfirmed validity,
japonicus (Peters, 1866), was known from the
Japan but was probably exterminated in the
(International Union for Conservation of Natu
Natural Resources 1972; Nichiwaki 1973). A
subspecies, *Z. c. wollebaeki* Sivertsen, 1953,
on the Galápagos Islands.

Genus NEOPHOCA Gray, 1866

Neophoca cinerea (Péron, 1816) (Australian se
Coastal waters from Kangaroo Island, Sout
tralia, to Houtman Rocks, Western Australia
is a late Pleistocene record from Melbourn
toria.

Genus EUMETOPIAS Gill, 1866

Eumetopias jubatus (Schreber, 1776) (northe
lion).

reeds along west coast of North America from San iguel Island, Calif., northwest to Prince William ound and the Alaska Peninsula, throughout the leutian and Pribilof islands, along the east coast of amchatka, throughout the Kuril Islands, and on slands in the Okhotsk Sea. Some move north into he Bering Sea in summer, as far as St. Lawrence Isand. Sometimes hauls out on ice. The spelling of *ubatus* follows a rule in International Trust for oological Nomenclature (1964:31): "a noun of ariable gender . . . is to be treated as mascune . . . ."

s CALLORHINUS Gray, 1859

orhinus ursinus (Linnaeus, 1758) (northern fur l).

reeds on Ostrov Tyuleniy (Robben Island) in the khotsk Sea, some of the Kuril Islands, the Pribilof nd Commander islands in the Bering Sea, and San iguel Island off southern California. Formerly bred n Ostrov Iony in the Okhotsk Sea 120 miles north of akhalin (Stejneger 1898), and possibly on Buldir Isand in the Aleutians (Murie 1959) and the Farallon slands off central California (Repenning et al. 971). Bones, including those of young pups, from an Miguel Island, the Monterey area, and Año uevo Point, Calif., and from Bella Bella, British olumbia, suggest that it formerly bred all along the est coast from San Miguel Island to Alaska Repenning, pers. commun.).

s ARCTOCEPHALUS E. Geoffroy Saint-Hilaire . Cuvier, 1826

he breeding ranges of the species of *rctocephalus* are strictly allopatric; further studies n the relationships of these seals are much needed. he present classification follows Repenning et al. 1971).

tocephalus pusillus (Schreber, 1776) (Giant fur l; Victorian, or Tasmanian, and South African, or pe, fur seals).

here are two widely separated subspecies. *Arcocephalus p. pusillus* breeds in temperate coastal aters from Cape Cross, South West Africa, to Algoa ay, South Africa; ranges north to Angola. *Arcocephalus p. doriferus* Wood Jones, 1925, breeds long the coast of southeastern Australia from Lady ulia Percy Island east to the Skerries, Victoria, inluding coasts of Tasmania and islands in Bass trait; ranges east to Port Stephens, N.S.W.

tocephalus gazella (Peters, 1875) (Antarctic fur l).

slands south of the Antarctic Convergence; South hetlands, South Orkneys, South Sandwich, South eorgia, Bouvet, Kerguelén (not breeding), Heard, nd McDonald.

Arctocephalus forsteri (Lesson, 1828) (Antipodean fur seal; Western Australian and New Zealand fur seals).

Breeds around South Island, N.Z., on nearby subantarctic islands (Chatham, Bounty, Antipodes, Auckland, Campbell, Macquarie, Snares, Stewart, and Solander), and along coast of southwestern Australia from Eclipse Island, Western Australia, to Kangaroo Island, South Australia.

Arctocephalus tropicalis (Gray, 1872) (subantarctic fur seal).

Subantarctic islands of Atlantic Ocean and Indian Ocean, north of the Antarctic Convergence (Tristan da Cunha, Gough, Marion, Prince Edward, Crozet (not breeding), Amsterdam, and St. Paul). Rarely wanders to South Africa, New Zealand, and Macquarie Island.

Arctocephalus australis (Zimmerman, 1783) (South American fur seal).

Falkland Islands; coasts of South America from Tierra del Fuego north to Rio de Janeiro, Brazil, and Lima, Peru. The proposed subspecific separation of the Falkland Islands and mainland populations is not justifiable (Vaz Ferreira 1976).

Arctocephalus galopagoensis Heller, 1904 (Galapagos fur seal).

Confined to the Galápagos Islands.

Arctocephalus philippii (Peters, 1866) (Juan Fernandez fur seal).

Now known to breed only on the Islas Juan Fernandez, Chile. Probably bred formerly on Isla San Felix and Isla San Ambrosio, Chile.

Arctocephalus townsendi Merriam, 1897 (Guadalupe fur seal).

Now known to breed only on Isla Guadalupe, Baja California. Occasionally seen on other islands off southern California and Baja California (San Miguel, San Nicholas, and Cedros), where it may have bred formerly. An old sealer's report from Isla Socorro (Morrell 1832) and bones from an Indian midden on Monterey Bay (Repenning, pers. commun.) suggest that it originally ranged more widely.

Family MUSTELIDAE

This family includes the weasels, badgers, otters, and their allies. Only the otters (subfamily Lutrinae) include marine species and only the sea otter is usually regarded as marine, although several species of river otters of the genus *Lutra*—especially the chungungo, *L. felina* (Molina, 1782), of Chile and Peru—feed extensively in salt water.

Genus ENHYDRA Fleming, 1822

Enhydra lutris (Linnaeus, 1758) (sea otter).
Formerly ranged from Morro Hermoso, Baja California, north along the coast to Prince William Sound and the south shore of the Alaska Peninsula, throughout the Aleutian, Pribilof, and Commander islands, along the southeast coast of Kamchatka, and through the Kuril Islands to northern Hokkaido. Three subspecies are recognizable (Roest 1973; Davis and Lidicker 1975): *E. l. nereis* (Merriam, 1904) from Mexico to Prince William Sound, Alaska; *E. l. lutris* from the Aleutian and Commander islands; and *E. l. gracilis* (Bechstein, 1799) in Kamchatka and the Kuril Islands. (The Aleutian race has been introduced into Oregon, Washington, British Columbia, and southeastern Alaska, where the indigenous stock was extirpated.)

Family PHOCIDAE

Genus PHOCA Linnaeus, 1758

Scheffer (1958) raised *Pusa* (including *hispida, caspica,* and *sibirica*), *Pagophilus* (*groenlandicus*), and *Histriophoca* (*fasciata*) to generic rank, but Burns and Fay (1970) have shown that they deserve only subgeneric rank.

Phoca vitulina Linnaeus, 1758 (harbor seal).
Shores of North America and Eurasia from Hokkaido, Baja California, North Carolina, and Spain north to the edge of arctic ice. Gives birth on land in May-August; the pup sheds its white coat in utero. The Atlantic subspecies, *P. v. vitulina*, is distinguishable from the Pacific subspecies by skull characters. Western North Atlantic seals are sometimes listed as a separate subspecies from those on the eastern side, but Doutt (1942) could find no differences between seals of the eastern and western Atlantic. *Phoca v. mellonae* Doutt, 1942, is said to be confined to the Seal Lakes complex of the Ungava Peninsula, though Mansfield (1967) doubted the validity of the subspecies. *Phoca v. richardii* (Gray, 1864) occurs in the eastern North Pacific west to the Aleutians, where it intergrades with *P. v. kurilensis* Inukai, 1942, of the western North Pacific (Shaughnessy 1974).

Phoca largha Pallas, 1811 (spotted seal; larga seal).
Chukchi, western Beaufort, northern Bering, Okhotsk, and Japan seas, southwest to the Shantung Peninsula, China. Reproductively isolated from *P. vitulina*, with which it is sympatric in the Kuril Islands and along the north shore of the Alaska Peninsula (Belkin 1964; McLaren 1966; Burns 1970). Gives birth on ice in late winter or spring and the pup retains its white coat for a week or more after birth.

Phoca hispida Schreber, 1775 (ringed seal).
Throughout the Arctic Ocean and adjacent seas, chiefly in fast ice, and in several Finnish lakes. geographically isolated peripheral population fairly well-defined subspecies, one each from Okhotsk Sea (*P. h. ochotensis* Pallas, 1811); the tic Sea (*P. h. botnica* Gmelin, 1788); Lake La (*P. h. ladogensis* Nordquist, 1899); and Lake Sai and adjacent lakes (*P. h. saimensis* Nordq 1899). Geographical variation in the Arctic O and Bering Sea populations, tentatively referab the nominate subspecies, requires much fu study.

Phoca sibirica Gmelin, 1788 (Baikal seal).
Only in Lake Baikal, U.S.S.R., a freshwater which freezes in winter.

Phoca caspica Gmelin, 1788 (Caspian seal).
Only in Caspian Sea, U.S.S.R., the northern e which freezes in winter.

Phoca groenlandica Erxleben, 1777 (harp seal).
North Atlantic Ocean, in pack ice from nort shores of Europe to eastern Canada. Breeds on ice in three main areas: the White Sea, north o Mayen, and Newfoundland. (The Newfounc seals breed in two centers: the "Front" north c island and the "Gulf" west of it.) Seals of the areas differ in size, cranial features, and body cc tion (Khuzin 1963, 1967; Yablokov and Serg 1963; Yablokov and Etin 1965). Subspecific n have been given to the Newfoundland stock, *groenlandica*, and that of the White Sea, *oceanica* Lepechin, 1778, but not to the Jan M stock (Smirnov 1927).

Phoca fasciata Zimmermann, 1783 (ribbon seal)
North Pacific Ocean, chiefly in pack ice, northern Hokkaido and the Okhotsk Sea to n western Alaska.

Genus HALICHOERUS Nilsson, 1820

Halichoerus grypus (Fabricius, 1791) (gray seal
Temperate coasts of the North Atlantic. The three breeding populations: one in the wester lantic from Newfoundland to Massachu another in the eastern Atlantic from the Britis (rarely France) and Iceland to the White Sea, third in the Baltic Sea. Seals of the western tic and Baltic populations pup in Februar March, seals of the eastern Atlantic from Se ber to December.

Genus ERIGNATHUS Gill, 1866

Erignathus barbatus (Erxleben, 1777) (bearded
Circumboreal at edges of ice; along all coasts lands of northern Eurasia and northern America. No subspecies are recognizable (K and Potelov 1971).

s CYSTOPHORA Nilsson, 1820

stophora cristata (Erxleben, 1777) (hooded seal; ddernose seal).
North Atlantic Ocean at edges of ice from Novaya Zemlya to eastern Canada. Jan Mayen, Newfoundand, and Davis Strait breeding stocks are perhaps listinct.

s MONACHUS Fleming, 1822

nachus monachus (Hermann, 1779) (Mediterlean monk seal).
The original range included the southern and vestern coasts of the Black Sea, the coasts and isands of the Mediterranean Sea, the coast of northvestern Africa southwestward to Cape Blanc, Mauritania, and the Madeira and Canary islands. Now rare or extirpated throughout much of its ange.

nachus tropicalis (Gray, 1850) (Caribbean monk l; West Indian monk seal).
Extinct (K. W. Kenyon, pers. commun.). In historic imes its range included shores and islands of the vestern Caribbean Sea, the Greater Antilles, the northern Lesser Antilles, the Bahamas, the Yucatan Peninsula, and the Florida Keys. In prehistoric imes ranged north to South Carolina.

nachus schauinslandi Matschie, 1905 (Hawaiian nk seal).
Breeds on Leeward Chain of the Hawaiian Islands, rom French Frigate Shoals to Kure Atoll; rarely vanders southeastward to Hawaii and south to Johnston Island.

s LOBODON Gray, 1844

bodon carcinophagus (Hombron and Jacquinot, 2) (crabeater seal).
Crabeaters are circumpolar and abundant in pack ce of the Southern Ocean; they straggle to southern ips of New Zealand, Australia, Tasmania, South Africa, and South America.

s OMMATOPHOCA Gray, 1844

matophoca rossii Gray, 1844 (bigeye seal; Ross l).
Circumpolar in pack ice of Antarctic Ocean.

s HYDRURGA Gistel, 1848

drurga leptonyx (de Blainville, 1820) (leopard seal).
Leopard seals are circumpolar in the Southern Ocean and are recorded from most subantarctic isands, as well as New Zealand, southern Australia, he Cook Islands, southern South America, and South Africa.

Genus LEPTONYCHOTES Gill, 1872

Leptonychotes weddelli (Lesson, 1826) (Weddell seal).
Circumpolar in fast ice around Antarctica, south to lat. 80°S in the Bay of Whales; straggling to subantarctic islands and as far north as Uruguay, lat. 35°S.

Genus MIROUNGA Gray, 1827

Mirounga leonina (Linnaeus, 1758) (southern elephant seal).
Circumpolar on subantarctic islands, south to edges of ice at lat. 78°S. The southern elephant seal breeds along a continental coast only at Argentina. Three subspecies have been proposed, one from the South American sector of the range, one from the southern Indian Ocean sector, and one from the New Zealand sector (Lydekker 1909). They may be valid, but further study is required before they can be accepted.

Mirounga angustirostris (Gill, 1866) (northern elephant seal).
Breeds from the Farallon Islands, Calif., south to Isla Guadalupe and Islas San Benito, Baja California. Formerly from Point Reyes, Calif., south to Cabo San Lázaro, Baja California. Ranges at sea north to southeastern Alaska.

Order SIRENIA

Family DUGONGIDAE

Genus DUGONG Lacépède, 1799

Dugong dugon (Müller, 1776) (dugong).
In tropical bays and estuaries of the Indian and western Pacific oceans from Lourenço Marques, Mozambique, and the Red Sea, east to the Ryukyu Islands (Amami Oshima), Palau, the Solomon Islands, the New Hebrides, New Caledonia, the Fiji Islands, and northern Australia. Carter et al. (1945) listed it from the Marshall Islands; if it ever occurred there it no longer does so. Now rare in all its range except along northern Australia.

Genus HYDRODAMALIS Retzius, 1794

Hydrodamalis gigas (Zimmermann, 1780) (great northern sea cow; Steller's sea cow).
Discovered in the Commander Islands in 1741, the sea cow was exterminated by Russian hunters about 1768. In historic time, it lived only on Bering and Copper islands and its total population probably did not exceed 1,000 or 2,000 animals. A rib was found on Attu, the westernmost Aleutian Island, in 1842 or 1843, by Ilia G. Wosnesenski. "There is no indisputable evidence of its ever having inhabited other coasts than those of the Commander Islands, as the find of a rib on Attu Island does not necessarily

prove that the animal once lived there, though that is not improbable" (Stejneger 1897). A skull fragment about 19,000 yr old was dredged from the sea floor off Monterey, Calif. (Jones 1967). Remains have also been recovered from Pleistocene deposits on Amchitka in the Aleutian Islands (Gard 1972). Recent rumors (Berzin et al. 1963) of living sea cows near Cape Navarin, Siberia, have been discredited.

Family TRICHECHIDAE

Genus TRICHECHUS Linnaeus, 1758

Three allopatric species are recognized (Hatt 1934), but their status needs confirmation.

Trichechus manatus Linnaeus, 1758 (Caribbean manatee; West Indian manatee).

Two doubtfully valid subspecies have been described: *T. m. manatus* from the sea coast, and lower reaches of rivers, from Bay of Campeche, Mexico, to northeastern South America, and in the Bahamas and the Greater Antilles; and *T. m. latirostris* (Harlan 1824) from the coast and coastal rivers of United States from Beaufort, N.C., to Florida Keys and coast of Gulf of Mexico, westward to mouth of Rio Grande.

Trichechus senegalensis Link, 1795 (West African manatee).

Coastal lagoons and the lower reaches of rivers from Sénégal to the Cuanza River, Angola, and in the Niger and Benue drainages of Nigeria.

Trichechus inunguis (Natterer, 1883) (Amazon manatee).

Rivers of northeastern South America, particularly the Amazon and Orinoco systems.

Order MYSTICETI

Family ESCHRICHTIIDAE

Genus ESCHRICHTIUS Gray, 1864

Eschrichtius robustus (Lilljeborg, 1861) (gray whale).

Shallow coastal waters of the North Pacific. There are two stocks, one on the eastern side from the Gulf of California to the Chukchi and Beaufort seas, another on the western side from Korea and Japan to the Okhotsk Sea; the latter stock is nearly extinct. Formerly in the North Atlantic.

Family BALAENOPTERIDAE

Genus BALAENOPTERA Lacépède 1804

Balaenoptera acutorostrata Lacépède, 1804 (minke whale).

Widely distributed in all oceans. Three subspecies are recognizable: *B. a. acutorostrata* in the North
Atlantic, *B. a. davidsoni* Scammon, 1872, in
North Pacific, and *B. a. bonaerensis* Burmeis
1867, in the Southern Hemisphere (Omura
Specimens from Ceylon have also been descrik
a separate subspecies, *B. a. thalmaha* Deraniyag
1963, but its validity requires confirmation.

Balaenoptera edeni Anderson, 1878 (Bryde wha

Tropical and warm temperate waters of the Atlan
Indian, and Pacific oceans.

Balaenoptera borealis Lesson, 1828 (sei whale).

All oceans except tropical and polar seas. Two s
species distinguished: a smaller one, *B. b. bor*
in the Northern Hemisphere and a larger one,
schlegellii Flower, 1865, in the Southern He
sphere.

Balaenoptera physalus (Linnaeus, 1758) (fin wh

All oceans, but rarely in tropical waters or am
pack ice. Two subspecies are recognized: a sma
Northern Hemisphere form, *B. p. physalus*, a
larger Southern Hemisphere form, *B. p.*
(Fischer, 1829).

Balaenoptera musculus (Linnaeus, 1758) (blue wh

All oceans. Three subspecies are recognized: a
one, *B. m. musculus*, in the North Atlantic
North Pacific; a large one, *B. m. intermedia*
meister, 1871, that spends the summer in Anta
waters; and a pygmy subspecies, *B. m. brevica*
Ichihara, 1966, in the southern Indian Ocean. (
name *B. m. brevicauda*, published by Zemsky
Boronin 1964, is a nomen nudum according t
Bree, pers. commun.; the first valid publicatio
the name was by Ichihara 1966.) The taxono
status of blue whales off the coasts of Chile and
and in the northern Indian Ocean is not settl

Genus MEGAPTERA Gray, 1846

Megaptera novaeangliae (Borowski, 1781) (hump
whale).

Nearly worldwide; winters largely in tropical w
near islands or the coast, summers in temperat
subpolar waters. This species shows little or
geographical variation in size; the several disc
populations differ in the frequency of
variations.

Family BALAENIDAE

Genus BALAENA Linnaeus, 1758

Some authors place *glacialis* in a separate g
Eubalaena Gray, 1864. Eschricht and Reinhardt (1
the only authors who have made a detailed compa
between *mysticetus* and *glacialis*, regarded them as
generic. Gray's generic name was ignored by virtual
subsequent authors until it was resurrected by

. Gray and Allen were two of the most notorious c "splitters" in the history of mammalogy (cf. n 1961:139). The differences between the two are no greater than those separating, e.g., the s species of *Balaenoptera*.

na glacialis Müller, 1776 (right whale; black whale).

emperate waters of the North Atlantic, the North cific, and the Southern Hemisphere. The thern populations are distinguishable as a parate subspecies (or species, according to some thors), *B. g. australis* Desmoulins, 1822, from *B. glacialis* of the North Atlantic (Muller 1954); rth Pacific populations are apparently identical those of the North Atlantic (Omura et al. 1969).

na mysticetus Linnaeus, 1758 (bowhead whale; ic right whale).

rctic waters. There are four geographically isolated pulations: 1) From Spitzbergen west to east eenland; 2) in Davis Strait, Baffin Bay, James ay, and adjacent waters; 3) in the Bering, Chuk- hi, and Beaufort seas; and 4) in the Okhotsk Sea. e Alaskan Eskimo recognize two kinds: the larger airalik" or true bowhead, and the smaller ingotok" (known as the "poggy" to the 19th cen- ry American whalers). I believe that the ingotok is st likely a young bowhead.

s CAPEREA Gray, 1864

rea marginata (Gray, 1846) (pygmy right whale).

emperate waters of Southern Ocean; known mostly om strandings on New Zealand, Australia, South erica, the Falkland Islands, and South Africa.

Order ODONTOCETI

cent years, several new family classifications of ntocetes have been proposed (Fraser and Purves Nishiwaki 1963; Kasuya 1973). I believe that insuf- evidence has been published to support the validi- ese classifications and that much more study is before any changes will be generally accepted. I ore follow tradition in regarding the living odon- as divisible into five families.

y PLATANISTIDAE

family includes three well-marked subfamilies are sometimes accorded family rank): Platanis- (*Platanista*), Iniinae (*Inia, Lipotes*), and Pon- inae (*Pontoporia*).

NIA d'Orbigny, 1834

eoffrensis (de Blainville, 1817) (bouto; Amazon in).

Amazon and Orinoco basins of South America. *Inia g. boliviensis* d'Orbigny, 1834, of the upper Madeira River system in Bolivia differs considerably from *I. g. geoffrensis* in the remainder of the Amazon basin and may be a distinct species (van Bree and Robineau 1973; van Bree, pers. commun.). The population in the Orinoco basin may also be subspecifically distinct.

Genus LIPOTES Miller, 1918

Lipotes vexillifer Miller, 1918 (pei c'hi; whitefin dolphin).

Lower Yangtze River from its mouth (Shanghai) upstream to Tung-t'ing Hu (Lake) and its tributaries. The English name "whiteflag" dolphin is based on an erroneous interpretation of the Chinese (M. Nishiwaki, pers. commun.).

Genus PONTOPORIA Gray, 1846

Pontoporia blainvillei (Gervais and d'Orbigny, 1844) (franciscana; La Plata dolphin).

Coastal waters and estuaries of eastern South America, from Baia de Santos, Brazil, to Golfo San Matias, Argentina.

Genus PLATANISTA Wagler, 1830

The two allopatric forms of this genus are regarded as subspecifically distinct by Kasuya (1972) and as specifically distinct by Pilleri and Gihr (1971). I tentatively list them as separate species on the advice of van Bree (pers. commun.).

Platanista gangetica (Roxburgh, 1801) (Ganges susu; Ganges dolphin).

Ganges-Brahmaputra-Meghna river system of India, Bangladesh, and Nepal, from tidal limits to the foothills. It is presumably this species that formerly occurred in the Karnaphuli River.

Plantanista minor Owen, 1853 (Indus susu; Indus dolphin).

Indus River system of Pakistan and India, from tidal limits to the foothills. (Most authors have used the name *P. indi* Blyth, 1859, but Owen's name has priority.)

Family DELPHINIDAE

Basic references on the classification of the Delphinidae are Flower (1883) and True (1889). The true porpoises (*Phocoena, Neophocaena*, and *Phocoenoides*) constitute a well-marked group that is sometimes accorded family rank (Phocoenidae). The remainder of the family has been variously subdivided or divided.

Genus STENO Gray, 1846

Steno bredanensis (Lesson, 1828) (rough-toothed dolphin.)

All tropical and warm temperate seas.

Genus SOUSA Gray, 1866

Sousa chinensis (Osbeck, 1765) (Indo-Pacific humpback dolphin; white dolphin).

Coastal waters of the Indian and western Pacific oceans, from Port Elizabeth, South Africa, north to the Red Sea and east to southern China (including lower reaches of the Yangtze, Foochow, and Canton rivers), Borneo, and northeastern and eastern Australia. The taxonomy of the humpbacked dolphins is greatly in need of revision. Several nominal species have been described, but individual, sexual, age, and geographic variations have not been adequately studied.

Sousa teuszii (Kükenthal, 1892) (Atlantic humpback dolphin).

Coastal waters of west Africa from Mauritania to Cameroon. This form could perhaps be regarded as a subspecies of *S. chinensis*, from which it differs mainly in tooth count (26-29 versus 32-36).

Genus SOTALIA Gray, 1866

Further taxonomic studies of this genus are needed. Two forms are recognized—one chiefly in coastal and estuarine waters, the other in fresh water. The differences between them are slight; they are best regarded as subspecies of a single species. (The Old World species formerly placed in *Sotalia* are now placed in a separate genus, *Sousa*.)

Sotalia fluviatilis (Gervais, 1853) (tucuxi; tookashee).

Sotalia f. fluviatilis occurs in the Amazon River and its tributaries; *S. f. guianensis* (van Beneden, 1864) occurs in coastal waters and lower reaches of rivers of northeastern South America, from Lake Maracaibo, Venezuela, to Santos, Brazil.

Genus TURSIOPS Gervais, 1855

Tursiops truncatus (Montagu, 1821) (bottlenose dolphin).

Widely distributed in temperate and tropical waters, including the Black Sea. Occurs mostly close to shore, near islands, and over shallow banks. Ranges north to Japan, Hawaii, California, New Brunswick, and Norway; south to southern Australia, New Zealand, Chile, Argentina, and South Africa. There is considerable geographical variation; populations in warmer waters of the Indo-Pacific tend to average smaller in body size and greater in snout length and tooth count.

Genus STENELLA Gray, 1866

The species of this genus fall into three groups or superspecies which are sympatric in many areas: 1) The spinner dolphins with long snouts, about 50 teeth in each jaw, and shallow palatal grooves. This group in
forms that differ markedly in body form and colo
tern, but intermediate populations connect the e
forms, so they are regarded as conspecific (Perri
1975a, b). Current studies indicate, however, that
is probably another species in the Atlantic similar t
sympatric with, the spinner dolphin (Perrin, pers
mun.). 2) The spotted and bridled dolphins with
snouts, about 37 teeth in each jaw, and no p
grooves. This group apparently includes two speci
ranges of which overlap in the Atlantic (Perrin 197
The striped dolphins, with about 44 teeth in each j
palatal grooves, a dark stripe along the flank, a
spots. Only one species is recognized (Fraser and
1970).

Stenella longirostris (Gray, 1828) (spinner dol
Tropical Atlantic, Indian, and Pacific ocean
species shows marked geographical variation.
central and eastern Pacific, Perrin (1972, 197
has described four subspecies: "Costa
"eastern," "whitebelly," and "Hawaiian"—
rect scientific names of which have not been
mined. [Although most recent authors hav
Gray's specific name, its applicability is
tionable (Perrin 1975b).]

Stenella attenuata (Gray, 1846) (bridled dolphi
tropical spotted dolphin).
Tropical Atlantic, Indian, and Pacific oceans
species also shows considerable geographical
tion. In the central and eastern Pacific, Perri
1975a, b) has described three subspecies: "c
S. a graffmani (Lönnberg, 1934), "offshore,
"Hawaiian"; the correct scientific names of t
ter two have not been determined. [For the
dolphins I provisionally use the specific nam
ployed by most recent authors, although their
ty is dubious. Other available names are *S*
(G. Cuvier, 1812) and *S. frontalis* (G. Cuvier,

Stenella plagiodon (Cope, 1866) (spotted dolphi
lantic spotted dolphin).
Tropical and warm temperate waters of A
Ocean. (See nomenclatorial note under pre
species).

Stenella coeruleoalba (Meyen, 1833) (strip
phin).
Widely distributed in temperate and tropical
around the world.

Genus DELPHINUS Linnaeus, 1758

Delphinus delphis Linnaeus, 1758 (saddleba
phin).
Widely distributed in warm temperate and tr
waters of all oceans, including the Black Sea
is marked geographical variation in snout len

her features; the extremely longsnouted Arabian ea form, *D. d. tropicalis* van Bree, 1971, may be a tinct species (van Bree and Purves 1972).

LAGENODELPHIS Fraser, 1956

nodelphis hosei Fraser, 1956 (shortsnouted belly dolphin).
ropical and warm temperate waters of Indian and cific oceans. Recorded from Natal, Japan, iwan, Philippines, Borneo, northeastern Aus-lia, and the central and eastern tropical Pacific.

LAGENORHYNCHUS Gray, 1846

s genus contains two well-defined species in the Atlantic and another in the North Pacific. Bier-nd Slijper (1947, 1948) regarded all Southern here forms as conspecific, but Fraser (1966) d that there are three distinct species. The species *ra* is now placed in a separate genus, *cephala*.

norhynchus albirostris (Gray, 1846) (whitebeak hin).
rth Atlantic from Davis Strait and Newfound-and east to the Barents Sea and North Sea (rarely the southern British Isles).

enorhynchus acutus (Gray, 1828) (Atlantic teside dolphin).
rth Atlantic from Massachusetts and southern eenland east to western Norway and the British sles.

norhynchus obliquidens Gill, 1865 (Pacific side dolphin; hookfin dolphin).
Vaters off the coast of North America from theastern Alaska to Baja California, and off the st of Asia from the Kuril Islands to Japan.

enorhynchus obscurus (Gray, 1828) (dusky dol-.
mperate waters off South America, South Africa, erguélen Island, southern Australia, and New ealand. Primarily a coastal species.

norhynchus australis (Peale, 1848) (blackchin phin).
emperate waters off southern South America and Falkland Islands.

enorhynchus cruciger (Quoy and Gaimard, 1824) glass dolphin).
nperate waters of the Southern Ocean. A pelagic ecies, found chiefly in waters immediately north of he Antarctic Convergence.

EPHALORHYNCHUS Gray, 1846

Four species are recognized (Harmer 1922).

Cephalorhynchus commersonii (Lacépède, 1804) (piebald dolphin; Jacobite).
Atlantic coast of South America from Golfo San Matias to Tierra del Fuego; Falkland Islands; South Georgia; and Kerguélen Island.

Cephalorhynchus eutropia (Gray, 1846) (black dolphin; Chilean dolphin).
Coast of Chile between lat. 37° and 55°S.

Cephalorhynchus heavisidii (Gray, 1828).
Coastal waters from Cape of Good Hope north to Cape Cross, South West Africa (P. B. Best, pers. commun.).

Cephalorhynchus hectori (van Beneden, 1881) (pied dolphin; whitefront dolphin).
Coastal waters of New Zealand.

Genus LISSODELPHIS Gloger, 1841

The two species of this genus differ, as far as is known, mainly in color pattern, and they should perhaps be regarded as subspecies of a single species.

Lissodelphis borealis (Peale, 1848) (northern rightwhale dolphin).
Temperate waters of the North Pacific from Japan and the Kurils to British Columbia and California. Individuals from Japan with a variant color pattern have been named *L. b. albiventris* Nishiwaki, 1972.

Lissodelphis peronii (Lacépède, 1804) (southern rightwhale dolphin).
Temperate waters of the Southern Ocean.

Genus GRAMPUS Gray, 1828

Grampus griseus (G. Cuvier, 1812) (whitehead grampus; gray grampus).
All temperate and tropical seas.

Genus PEPONOCEPHALA Nishiwaki and Norris, 1966

Peponocephala electra (Gray, 1846) (little blackfish; many-toothed blackfish; melon-head blackfish).
Tropical Atlantic, Indian, and Pacific oceans.

Genus FERESA Gray, 1871

Feresa attenuata Gray, 1875 (pygmy killer whale).
Tropical and warm temperate waters of the Atlantic, Indian, and Pacific oceans.

Genus PSEUDORCA Reinhardt, 1862

Pseudorca crassidens (Owen, 1846) (false killer whale).
All temperate and tropical seas.

Genus GLOBICEPHALA Lesson, 1828

There appear to be two well-defined species, the ranges of which overlap off the middle Atlantic coast of the United States, off southern Europe, off South Africa, and perhaps elsewhere (van Bree 1971).

Globicephala melaena (Traill, 1809) (longfin pilot whale).
Nominate subspecies in the cool temperate North Atlantic Ocean; *G. m. edwardii* A. Smith, 1834, throughout cool temperate waters of the Southern Hemisphere. The validity of the subspecific distinction is questionable. Occurred in the North Pacific (near Japan) until at least the 10th century A.D. (Kasuya 1975).

Globicephala macrorhynchus Gray, 1846 (shortfin pilot whale).
Tropical and warm temperate waters of the Atlantic, Indian, and Pacific oceans. *Globicephala sieboldii* Gray, 1846, of the North Pacific is conspecific with *G. macrorhynchus*, although it may be recognizable at the subspecific level. (The specific name is usually spelled *macrorhyncha*, but it is a noun in apposition, not an adjective, so must retain its original gender.)

Genus ORCINUS Fitzinger, 1860

Orcinus orca (Linnaeus, 1758) (killer whale).
All oceans, chiefly in coastal waters and cooler regions.

Genus ORCAELLA Gray, 1866

Orcaella brevirostris (Gray, 1866) (Irrawaddy dolphin; lumbalumba).
Coastal waters from the Bay of Bengal east to New Guinea and northern Australia; ascends far up the Mekong, Irrawaddy, Ganges, and other rivers.

Genus PHOCOENA G. Cuvier, 1817

The genus includes four species (Norris and McFarland 1958; Noble and Fraser 1971).

Phocoena phocoena (Linnaeus, 1758) (harbor porpoise).
Coastal waters of the North Atlantic from Delaware and Sénégal north to Davis Strait, Iceland, and the White Sea; coastal waters of the North Pacific from Japan and Baja California north to Point Barrow, Alaska. An isolated population in the Black Sea has been named *P. p. relicta* Abel, 1905.

Phocoena sinus Norris and McFarland, 1958 (vaquita; cochito; Gulf of California porpoise).
Upper Gulf of California; sight records farther south are questionable.

Phocoena dioptrica Lahille, 1912 (spectacled p poise).
Coast of Argentina and Uruguay; the Falkl lands; and South Georgia.

Phocoena spinipinnis Burmeister, 1865 (black poise).
East coast of South America from Urug Patagonia; west coast from Paita, Peru, to Valdi Chile.

Genus NEOPHOCAENA Palmer, 1899

Neophocaena phocaenoides (G. Cuvier, 1829) porpoise).
Warm coastal waters and certain rivers from tan east to Korea, Japan, Borneo, and Java. type-specimen allegedly came from the C Good Hope, but Peter Best (pers. commun.) that there are no indisputable South Afri records.) Specimens from China and Japan from Indian Ocean specimens, and are best re as a subspecies, *N. p. asiaeorientalis* (Pille Gihr, 1971), rather than a full species as origin described (van Bree 1973). More recently Pill Gihr (1975) have differentiated three all forms which they arbitrarily rank as species. *phocaenoides* from Pakistan to Borneo, *asiaeorientalis* from China, and *N. sunameri* and Gihr, 1975, from Japan and Korea. The lished data are inadequate to reveal whether Japanese and Chinese populations are sufficie separable to warrant recognition of *sunameri* a subspecies.

Genus PHOCOENOIDES Andrews, 1911

Phocoenoides dallii (True, 1885) (Dall po whiteflank porpoise).
Immediate offshore waters of the North Pacif Japan and southern California north to the so Bering Sea. "True's porpoise" is a color localized in Japanese waters.

Family MONODONTIDAE

Some authors have included the narwhal and belu the family Delphinidae.

Genus DELPHINAPTERUS Lacépède, 1804

Delphinapterus leucas (Pallas, 1776) (beluga; b white whale).
Arctic Ocean and adjacent seas; including Ok and Bering Seas, and James Bay; isolate ulations occur in Cook Inlet, Alaska, and the St. Lawrence; ascends several hundred m larger rivers of Siberia and Alaska. Some au recognize three subspecies: a large one, *dorofeevi* Barabash and Klumov, 1935, fr

khotsk Sea; a small one, *D. l. marisalbi* stroumov, 1935, in the Barents and White seas; a medium-sized one, *D. l. leucas*, in the rest of range. However, geographical variation is more mplex than this classification suggests (Sergeant d Brodie 1969).

MONODON Linnaeus, 1758

odon monoceros Linnaeus, 1758 (Narwhal).
rth polar seas, mainly in deep waters.

PHYSETERIDAE

genus *Kogia* is sometimes placed in a separate (Kogiidae).

PHYSETER Linnaeus, 1758

eter macrocephalus Linnaeus, 1758 (sperm).
ll oceans (except polar ice fields). (For use of this me instead of *P. catodon* Linnaeus, 1758, see sson and Holthuis 1974.)

KOGIA Gray, 1846

lley (1966) has reviewed the distinguishing es of the two species in this genus.

breviceps (de Blainville, 1838) (pygmy sperm).
orld-wide in tropical and warm temperate waters.

simus Owen, 1866 (dwarf sperm whale).
e seas adjacent to South Africa, India, Ceylon, apan, Hawaii, California, Baja California, and tern United States.

ZIPHIIDAE

Moore (1968) for diagnoses of the genera.

BERARDIUS Duvernoy, 1851

allopatric species are recognized. The North form differs from the Southern Hemisphere form by its much larger size. Possibly it should be ed as only a subspecies of the Southern Hemi- form.

rdius arnuxii Duvernoy, 1851 (southern giant bot- se whale).
thern Ocean; known from South Australia, New land, Argentina, Falkland Islands, South eorgia, South Shetlands, South Africa, and off the tarctic Peninsula.

rdius bairdii Stejneger, 1883 (North Pacific giant tlenose whale).
rth Pacific from Japan and southern California th to the Bering Sea.

Genus ZIPHIUS G. Cuvier, 1823

Ziphius cavirostris G. Cuvier, 1823 (goosebeak whale).
All temperate and tropical seas.

Genus TASMACETUS Oliver, 1937

Tasmacetus shepherdi Oliver, 1937.
Known only from a few specimens stranded in New Zealand, Chile, and Argentina.

Genus INDOPACETUS Moore, 1968

The one species of this genus was formerly included in *Mesoplodon*.

Indopacetus pacificus (Longman, 1926) (Indo-Pacific beaked whale).
Known from only two specimens stranded at Mackay, Queensland, Australia, and Danane, Somalia.

Genus HYPEROODON Lacépède, 1804

Two well-defined species are recognized: one in the North Atlantic, the other in the Southern Hemisphere. The latter constitutes subgenus *Frasercetus* Moore, 1968. The occurrence of *Hyperoodon* in the North Pacific has never been verified, and most if not all published records of its occurrence there are based on misidentification of *Berardius*. Beaked whales possibly referable to *Hyperoodon* are taken by whalers off the Okhotsk Sea coast of Hokkaido, but to date none has been examined by a biologist (M. Nishiwaki, pers. commun.).

Hyperoodon ampullatus (Forster, 1770) (North Atlantic bottlenose whale).
North Atlantic from Davis Strait and Novaya Zemlya south to Rhode Island and the English Channel; doubtfully recorded from the Mediterranean Sea.

Hyperoodon planifrons Flower, 1882 (flathead bottlenose whale).
Southern Ocean; known from Australia, New Zealand, Argentina, the Falkland Islands, South Georgia, the South Orkney Islands, South Africa, and off the coast of Antarctica in the Pacific and Indian Ocean sectors.

Genus MESOPLODON Gervais, 1850

Eleven species are currently recognized by Moore (1968). *Mesoplodon pacificus* is now placed in a separate genus, *Indopacetus*. *Mesoplodon layardii* is placed in the subgenus *Dolichodon* Gray, 1871; *M. densirostris* in the subgenus *Dioplodon* Gervais, 1850; and the remaining species are placed in subgenus *Mesoplodon*.

Mesoplodon hectori (Gray, 1871).
Known only from Tasmania, New Zealand, the Falkland Islands, and South Africa.

Mesoplodon mirus True, 1913.
North Atlantic from Florida and Nova Scotia east to the British Isles; an apparently isolated population in temperate waters off South Africa.

Mesoplodon europaeus (Gervais, 1855) (Antillean beaked whale; Gulf Stream beaked whale).
Western North Atlantic from Trinidad, Jamaica, and the Gulf of Mexico, to Long Island, N.Y.; one record from the English Channel.

Mesoplodon ginkgodens Nishiwaki and Kamiya, 1958 (ginkgo-tooth whale).
Recorded from Ceylon, Taiwan, Japan, and California.

Mesoplodon grayi von Haast, 1876 (scamperdown whale).
South Africa, South Australia, New Zealand, Chatham Islands, and Argentina; one record from the Netherlands.

Mesoplodon carlhubbsi Moore, 1963 (archbeak whale).
Temperate waters of the North Pacific from Japan east to British Columbia and California.

Mesoplodon bowdoini Andrews, 1908 (deepcrest whale).
Known only from New Zealand, Tasmania, Western Australia, Victoria, and Kerguélen Island.

Mesoplodon stejnegeri True, 1885 (sabertooth whale; Bering Sea beaked whale).
Subarctic waters of the North Pacific from the Bering Sea south to Japan and Oregon.

Mesoplodon bidens (Sowerby, 1804) (North Sea beaked whale).
Cool temperate waters of the North Atlantic from Newfoundland and Massachusetts east to southern Norway and the Bay of Biscay.

Mesoplodon layardii (Gray, 1865) (straptooth whale).
South Africa, southern Australia, New Zealand, and the Falkland Islands.

Mesoplodon densirostris (de Blainville, 1817) (densebeak whale; tropical beaked whale).
Tropical and warm temperate waters of all oceans.

SYNONYMS

Listed below are generic and specific synonyms frequently appearing in recent literature.

In recent literature	In present list
Arctocephalus doriferus	*Arctocephalus pusillu*
A. elegans	*A. tropicalis*
A. tasmanicus	*A. pusillus*
Arctophoca	*Arctocephalus*
Balaena australis	*Balaena glacialis*
B. japonica	*B. glacialis*
B. sieboldii	*B. glacialis*
Balaenoptera bonaerensis	*Balaenoptera acutoros*
B. brydei	*B. edeni*
B. davidsoni	*B. acutorostrata*
B. huttoni	*B. acutorostrata*
Callorhinus alascensis	*Callorhinus ursinus*
C. curilensis	*C. ursinus*
C. cynocephalus	*C. ursinus*
C. mimicus	*C. ursinus*
Cephalorhynchus albifrons	*Cephalorhynchus hectori*
C. albiventris	*C. eutropia*
Delphinapterus dorofeevi	*Delphinapterus leucas*
D. friemani	*D. leucas*
Delphinus bairdii	*Delphinus delphis*
D. capensis	*D. delphis*
D. dussumieri	*D. delphis*
D. longirostris	*D. delphis*
D. roseiventris	*Stenella longirostris*
D. tropicalis	*Delphinus delphis*
Electra	*Peponocephala*
Eschrichtius gibbosus	*Eschrichtius robustus*
E. glaucus	*E. robustus*
Eubalaena	*Balaena*
Eumetopias stellerii	*Eumetopias jubatus*
Feresa intermedia	*Feresa attenuata*
F. occulta	*F. attenuata*
Globicephala brachyptera	*Globicephala macrorhynchus*
G. edwardii	*G. melaena*
G. leucosagmaphora	*G. melaena*
G. scammonii	*G. macrorhynchus*
G. sieboldii	*G. macrorhynchus*
Grampidelphis	*Grampus*
Grampus orca	*Orcinus orca*
G. rectipinna	*O. orca*
Gypsophoca	*Arctocephalus*
Histriophoca	*Phoca*
Hydrodamalis stelleri	*Hydrodamalis gigas*
Hyperoodon rostratus	*Hyperoodon ampullat*
Lagenorhynchus electra	*Peponocephala electr*
L. fitzroyi	*Lagenorhynchus obscur*
L. ognevi	*L. obliquidens*
L. superciliosus	*L. obscurus*
L. thicolea	*Lagenorhynchus* sp.?
L. wilsoni	*L. cruciger*
Megaptera nodosa	*Megaptera novaeangli*
Meomeris	*Neophocaena*
Mesoplodon gervaisi	*Mesoplodon europaeus*
M. hotaula	*M. gingkodens*
M. pacificus	*Indopacetus pacificus*

chus albiventer	*Monachus monachus*
alaena	*Caperea*
ris	*Neophocaena*
ca hookeri	*Phocarctos hookeri*
batus	*Neophoca cinerea*
s	*Mesoplodon*
us divergens	*Odobenus rosmarus*
a fluminalis	*Orcaella brevirostris*
la	*Orcaella*
us rectipinna	*Orcinus orca*
yronia	*Otaria flavescens*
ilus	*Phoca*
a insularis	*Phoca vitulina*
ensis	*P. vitulina*
rdii	*P. vitulina*
ena vomerina	*Phocoena phocoena*
enoides truei	*Phocoenoides dallii*
r catodon	*Physeter macrocephalus*
sta indi	*Platanista minor*
lphinus	*Stenella*
	Phoca
nectes	*Eschrichtius*
a	*Hydrodamalis*
ldus	*Balaenoptera*
borneensis	*Sousa chinensis*
liensis	*Sotalia fluviatilis*
ensis	*Sousa chinensis*
damu	*Tursiops truncatus*
ensis	*Sotalia fluviatilis*
ginosa	*Sousa chinensis*
lida	*Sotalia fluviatilis*
mbea	*Sousa chinensis*
sis	*S. chinensis*
ii	*S. teuszii*
uxi	*Sotalia fluviatilis*
borneensis	*Sousa chinensis*
ginosa	*S. chinensis*
bea	*S. chinensis*
eenslandensis	*S. chinensis*
a alope	*Stenella longirostris*
a	*Stenella* (?) *attenuata*
rosyne	*S. coeruleoalba*
ntalis	*Stenella* (?) *attenuata*
mani	*S. attenuata*
yana	*Sousa chinensis* (fide van Bree, pers. commun.)
crops	*Stenella longirostris*
ttensis	*Stenella* (?) *plagiodon*
entris	*S. longirostris*
x	*S. coeruleoalba*
ostratus	*Steno bredanensis*
lphis	*Pontoporia*
inchus	*Hydrurga*
rhynchus	*Hydrurga*
	Platanista
tos	*Ursus*
echus latirostris	*Trichechus manatus*
ops abusalum	*Tursiops truncatus*
cus	*T. truncatus*
ania	*T. truncatus*
T. gadamu	*T. truncatus*
T. gillii	*T. truncatus*
T. nesarnack	*T. truncatus*
T. nuuanu	*T. truncatus*
Zalophus cinereus	*Neophoca cinerea*
Z. japonicus	*Zalophus californianus*
Z. lobatus	*Neophoca cinerea*
Z. wollebaeki	*Zalophus californianus*

ACKNOWLEDGMENTS

Victor B. Scheffer, coauthor of the previous two editions, reviewed the entire manuscript. P. J. H. van Bree and C. A. Repenning reviewed in detail the sections on cetaceans and pinnipeds, respectively. P. B. Best, W. F. Perrin, and P. D. Shaughnessy provided valuable comments on portions of the manuscript.

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☆GPO 797-502

NOAA Technical Report NMFS SSRF-712

Annual Physical and Chemical Oceanographic Cycles of Auke Bay, Southeastern Alaska

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and Bruce L. Wing

May 1977

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nnual Physical and Chemical Oceanographic Cycles of Auke Bay, Southeastern Alaska

HERBERT E. BRUCE, DOUGLAS R. McLAIN, and BRUCE L. WING[1]

ABSTRACT

The annual cycles of physical and chemical oceanographic conditions in Auke Bay, a small estuary in southeastern Alaska, showed a consistent pattern over an 8-yr period (1961-68). The cycles closely followed seasonal climatological and atmospheric events. Increased insolation in the spring caused general warming of the surface water and the air, which in turn increased the freshwater input into Auke Bay from melting snow and ice. The fresh water lowered surface salinities and together with warming of the surface waters caused a density stratification of the water column, which increased as the spring-summer season progressed. Maximum stratification occurred in August, followed by a general decay of stratification in September. Vertical mixing of the top 20 m of the water column by fall storms in September and cooling of surface water resulting from decreased insolation set up a thermohaline circulation that continued through the fall and early winter. The water column became homogeneous by January and remained thoroughly mixed from January through March or early April.

Auke Bay was rich in the inorganic nutrients phosphate, silicate, and nitrate. Spring phytoplankton blooms followed the onset of stratification and drastically reduced the concentration of all three nutrients in the surface water. Nitrate was essentially depleted and remained so throughout the summer. Low nitrate availability was undoubtedly one of the important factors limiting primary production in Auke Bay.

INTRODUCTION

uke Bay is one of the many small bays along the straits and passages of the inside waters of eastern Alaska. Although these bays represent a percentage of the total water mass of the area, they important as spawning and nursery grounds for l species of fish and shellfish. Streams tributary to Bay are spawning grounds for four species of salm- pink, *Oncorhynchus gorbuscha*; chum, *O. keta*; o, *O. kisutch*; and sockeye, *O. nerka*. Herring, *Clupea gus pallasi*; king crabs, *Paralithodes camtschatica . platypus*; snow crab, *Chionoecetes bairdi*; and er species of commercial and recreational value wn in the bay itself.

eral reports describe aspects of physical and cal oceanography of small bays and estuaries in theastern Alaska. Barnes et al. (1956) made an in- e survey (including some biological observations) ver Bay on Baranof Island near Sitka before con- tion of a pulp mill. Powers (1963) examined Little t Walter at the southern end of Baranof Island. The Federal Water Pollution Control Administration made surveys of Gastineau Channel and Fritz Cove near Juneau and of Silver Bay and Ward Cove near Ketchikan in the summer of 1965. McLain (1968) surveyed Traitors Cove on Revillagigedo Island. McLain (1969) described seasonal changes in oceanographic conditions in Lynn Canal. Nebert and Matthews (1972) described the circulation of Endicott Arm. Most of these studies were less than 2-yr duration, not long enough to separate short-term and protracted hydrographic disturbances known to occur in natural environments.

Therefore, in our study of Auke Bay, the objective was to describe the annual cycles of oceanographic conditions in the bay over several years. In this way the complete annual cycle and the range of natural environmental variability could be identified. From this information the biological consequences of normal cycles and anomalous oceanographic conditions could be assessed.

DESCRIPTION OF STUDY AREA

Physiography and Geology

Auke Bay is one of a large number of small embayments off a system of large fiords connecting with the open ocean (Fig. 1). It is located at lat. 58°22′N and long. 134°40′W, 19.3 km northwest of Juneau, Alaska, and about 130 km inland from the open Gulf of Alaska. The bay covers an area of about 11 km^2 and contains several small islands and reefs.

The bottom topography of the bay is irregular, and submarine gulleys and mounts are quite common (Fig.

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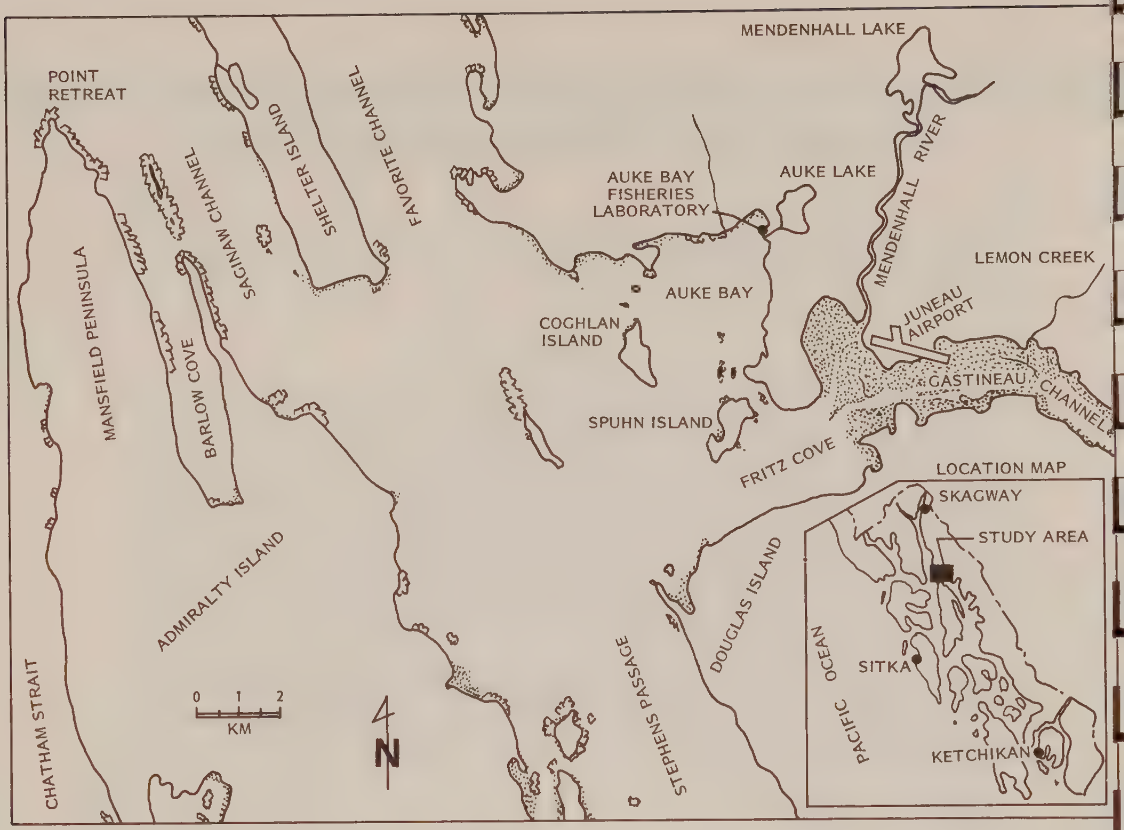

MENDENHALL LAKE
POINT RETREAT
SHELTER ISLAND
FAVORITE CHANNEL
SAGINAW CHANNEL
AUKE BAY FISHERIES LABORATORY
AUKE LAKE
MENDENHALL RIVER
MANSFIELD PENINSULA
BARLOW COVE
LEMON CREEK
AUKE BAY
JUNEAU AIRPORT
COGHLAN ISLAND
GASTINEAU CHANNEL
SPUHN ISLAND
FRITZ COVE
LOCATION MAP
SKAGWAY
STUDY AREA
ADMIRALTY ISLAND
DOUGLAS ISLAND
PACIFIC OCEAN
SITKA
CHATHAM STRAIT
0 1 2
KM
N
STEPHENS PASSAGE
KETCHIKAN

Figure 1.—Auke Bay, Alaska, and surrounding area.

2). The maximum depth, 100 m, is near the south end of Coghlan Island; depths of 40 to 60 m are common over much of the bay.

Auke Bay is not a fiord-type estuary of the form described by Pritchard (1952), but is a small tributary embayment to a system of large fiords. Lynn Canal-Icy Strait-Chatham Strait and Stephens Passage-Frederick Sound-Chatham Strait are major interconnected passages in southeastern Alaska and provide communication between Auke Bay and the Gulf of Alaska. The entire region was heavily glaciated during the Pleistocene Eopch. Martin and Williams (1924) concluded that glacial deepening of a preexisting river valley was the primary process in the formation of the Chatham Strait-Lynn Canal fiord. Auke Bay may have formed as a side valley of the larger fiord system.

Climatology

Auke Bay lies within that part of the maritime province extending along the northwest coast of North America. Winds in this area are predominantly southerly off the Pacific Ocean. These warm, moisture-laden winds strike the high coastal ranges and result in abundant precipitation, little sunshine, and moderate air temperatures. Observations by the National Weather Service at the Juneau Airport 3 km east of Auke Bay are that precipitation in the area is lightest in the spri
heaviest in the fall (Fig. 3). Between February an
the average monthly precipitation rate is fairly cons
(the monthly average for 1931-60 was 6.6 cm). Pre
tion increases rapidly in June and reaches a maxim
October (the 30-yr average for October 1931-60 wa
cm).[2] After the October maximum, precipita
decreases until February.

The average monthly insolation for the Auke Ba
from 1959 to 1962 is shown in Figure 4. Insolation, w
we estimated from cloud cover data, is a predomi
factor in controlling seasonal cycles of air and se
face temperature. Data from Roden (1959) on th
amount of radiation received at sea level under clou
skies were converted to insolation under cloud cov
cording to the equation of Sverdrup et al. (1942)

$$Q_i = Q_0(1-0.071\ C)$$

where Q_i = radiation received at sea level adjus
cloud cover
Q_0 = total incoming radiation under clou
skies
C = amount of clouds (in tenths of sky co

---

[2] The average was calculated from data in the U.S. Weather B
annual publication Climatological Data, vols. 17-46, Alaska sec
13).

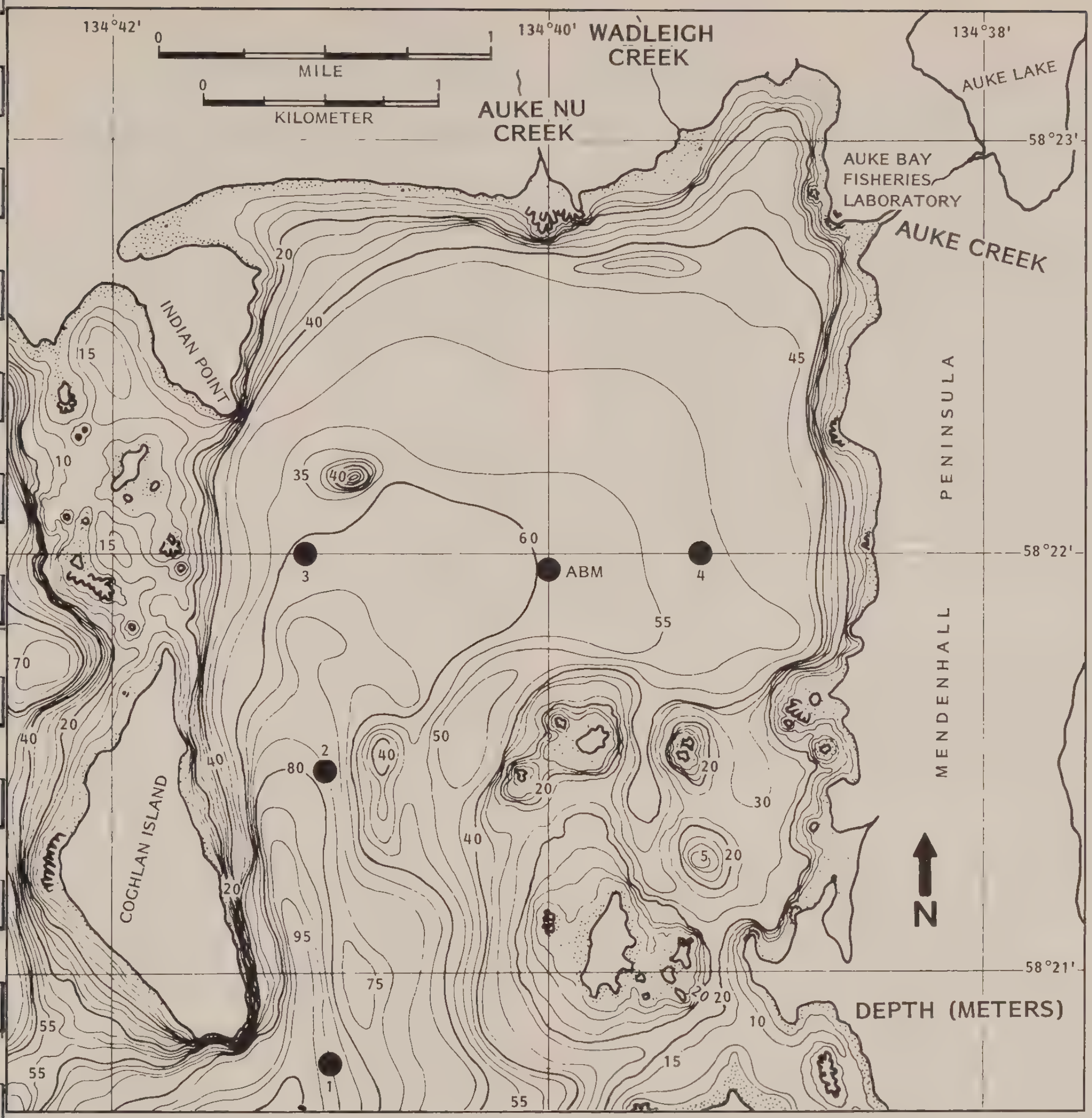

134°42'
0
1
MILE
0
1
KILOMETER
134°40'
WADLEIGH CREEK
AUKE NU CREEK
134°38'
AUKE LAKE
58°23'
AUKE BAY FISHERIES LABORATORY
AUKE CREEK
INDIAN POINT
20
40
45
15
10
35
40
15
60
3
ABM
4
58°22'
55
PENINSULA
MENDENHALL
70
20
40
40
2
80
50
40
20
20
30
COGHLAN ISLAND
40
5
20
N
20
95
75
58°21'
20
20
10
DEPTH (METERS)
15
55
55
1
55

Figure 2.—Bathymetry of Auke Bay, Alaska, and locations of oceanographic stations.

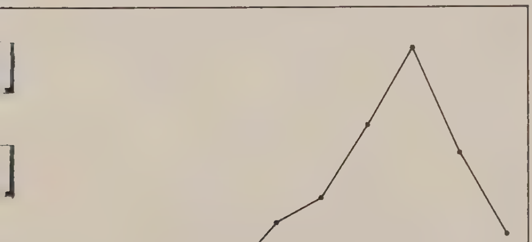


Figure 3.—Average monthly precipitation (cm of water) at Juneau airport, 1931-60. (See text footnote 2.)

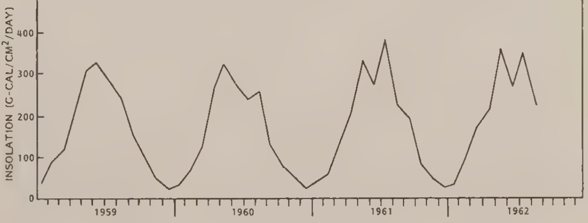


Figure 4.—Monthly averages of daily insolation (g-cal/cm^2/day) in Auke Bay area, 1959-62. (See text for calculation of insolation.)

Runoff

The streams entering directly into Auke Bay are small and drain low-elevation (less than 900 m) forested areas. The streams are fed by rainfall and melting winter snows, and discharge from them has several maxima and minima each year that vary in timing from year to year. These are Auke Creek, Auke Nu Creek, Wadleigh Creek, and several smaller unnamed streams.

The larger more distant Mendenhall River and Lemon Creek discharge into Fritz Cove and Gastineau Channel adjacent to Auke Bay. Their waters eventually enter Auke Bay. The watersheds of these larger streams are rocky slopes, ice and snow fields, and glaciers. The monthly discharge follows an annual cycle, with a single minimum in February or March and a single maximum in July (U.S. Geological Survey 1964). The winter minimum is caused by a decreased rate of snowmelt at higher elevation and the summer maximum by a combination of increased snowmelt and moderate precipitation.

Tides

The tides in Auke Bay are semidiurnal and show diurnal inequality. The mean tidal range is slightly more than 4 m (U.S. Coast and Geodetic Survey 1962). Spring tides exceed this by almost 2 m. The times and heights of high and low water are nearly the same over the entire Auke Bay area.

PHYSICAL AND CHEMICAL OCEANOGRAPHIC FEATURES OF AUKE BAY

The Northwest and Alaska Fisheries Center Auke Bay Laboratory has collected descriptive physical and chemical oceanographic data in Auke Bay since 1959. These oceanographic observations have been parts of a variety of projects with differing needs and goals, so the schedules and types of observations have varied over the years. The seasonal cycles described in this report are derived primarily from data collected from 1961 to 1967, supplemented by some earlier and later observations.

Five oceanographic stations (Fig. 2) were occupied monthly during 1961-63. The local variations within the bay were relatively small when compared with the frequent transient vagaries. Oceanographic properties appeared to be homogeneously distributed over the area of the bay, and differences were usually within the limits of error in our measurements. Consequently, beginning in March 1963, the five stations were replaced with a single midbay station, Auke Bay Monitor (ABM, Fig. 2) which was monitored monthly for 1 yr. From March 1964 through July 1967, the ABM station was occupied approximately weekly in order to define more precisely short-term variations in oceanographic conditions associated with use of amino acids as a nitrogen source by the phytoplankton (Bruce 1969).

The observations were made with conventional
sen bottles and reversing thermometers from
research vessels *Sablefish* and *Murre II* and from va
small boats. The accuracy of the tempera
measurements was estimated ±0.05°C. Salinities dur
the years 1959-64 were measured by titration, accurate
±0.01°/₀₀, and later by salinometer, accurat
±0.05°/₀₀. Concentration of dissolved oxygen
measured by the conventional Winkler technique,
curate to ±0.1 ml/liter. Phosphates, nitrates, a
silicates were determined by the methods of Strick
and Parsons (1960) and are believed within the prec
limits of ±0.05, ±0.3, and ±3.0 μg-at./liter respective

Temperature

Water temperature is one of the most importa
characteristics of marine environments. The
tribution of water temperature and salinity influ
the physical mixing properties of the water. In additio
temperatures, along with salinities, are useful in ide
tifying masses of water and in monitoring chang
physical and chemical properties of marine env
ments. Finally, temperature and temperature chan
affect metabolism and other processes in marine pla
and animals. Accordingly, this subject has been
fully investigated than any other physical factor.

The surface water temperature in Auke Bay rang
from less than 2° to 17°C; an extended minimum
curred between January and March and a maximu
August (Fig. 5). Sea surface temperatures were gre
than the maximum air temperatures during the mont
of November to February, reflecting large heat loss
the atmosphere during the winter. Temper
variations were greatest at the surface and decreas
with increasing depth (Fig. 6). At a depth of 50 m,
temperature ranged from 2° to 7.8°C. The month of
imum water temperature was progressively later i
summer at progressively greater depths. For examp
the surface maximum was reached in August, and
maximum at 50 m was reached in October or Noven

During the year vertical temperature profiles ch
from well mixed to strongly stratified (Fig. 7). In Janua

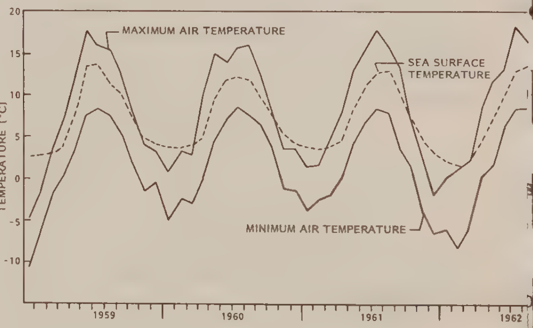
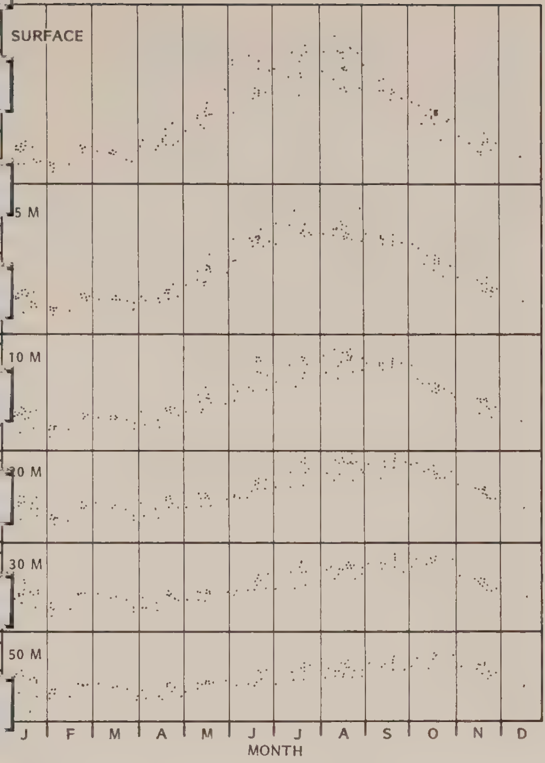


Figure 5.—Monthly averages of daily maximum and minimum
temperatures (°C) recorded at Juneau, Alaska, airport and
surface temperature (°C) at Auke Bay, Alaska, 1959-62.



6.—Observed water temperatures (°C) at selected depths in Auke Bay, Alaska, 1960-68.

water column is isothermal to a depth of 50 m. In the surface waters begin to warm and start develop- of a thermocline. Between April and July, surface ming continues and by late July extends from 10 m. ser gradient in temperature exists from 10 to 30 nd below 30 m the temperature changes very little. he thermocline proper, a 10°C temperature dif- nce may be encountered in July and August. After September, the thermocline decays because of nt heat losses and mixing by fall storms. The effect torms is to change the distribution of heat, as illus- ed by the decrease in the temperature of the surface rs to a depth of 10 m and a warming of the water 10 m by vertical mixing. Between October and uary, vertical mixing and cooling of the surface water tinue, and in January conditions are again isother- to a depth of 50 m.

inity

we exclude those areas close to the outflow of large rs or close to melting ice, the salinities of the world's s range from 32 to 38‰. The salinities of es- es, however, are much more variable in time and e, ranging from near zero to more than 30‰. This e variation is important as a selective agency in mining the composition and structure of biological unities.

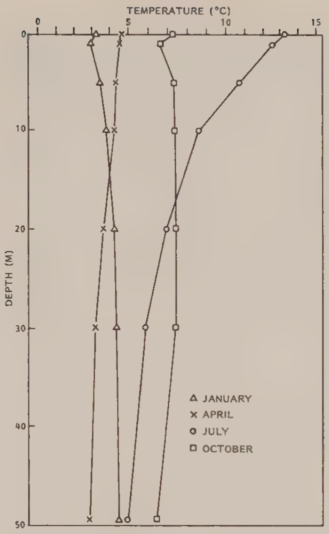


Figure 7.—Typical profiles of temperature (°C) in Auke Bay, Alaska, for January, April, July, and October; data are averages for 1960-68.

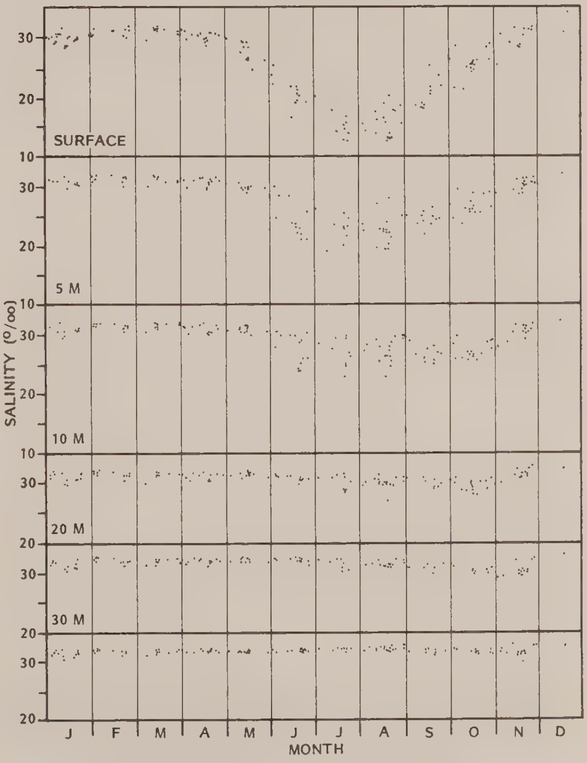


Figure 8.—Observed salinities (‰) at selected depths in Auke Bay, Alaska, 1960-68.

Variation of salinity at selected depths in Auke Bay from 1960 to 1968 is shown in Figure 8. In general, the annual cycle of salinity in the top 10 m was characterized by 1) a period from January to April when salinity remained between 29 and 31‰, 2) a period between May and July-August when salinity decreased to a minimum of about 17‰, and 3) a recovery period (September-December) when salinity increased again to the winter values. In deeper water (20 to 50 m) the salinity remained rather constant at 30 to 31 °/₀₀ through the year. The salinity of surface waters varied 3 to 5 °/₀₀ in a few days during the spring-fall period while short-term variations in the deeper water seldom exceeded 1 °/₀₀.

Two distinct layers of water—surface (to 30 m) and deep (below 30 m)—appear in the vertical profiles of salinity in Auke Bay (Fig. 9). Between January and April, isohaline conditions exist from the surface to 50 m. The salinity of the surface layer decreases continuously from April through July or August, and a strong salinity gradient forms in the top 10 to 12 m. The strongest halocline occurs in July with salinities near 20 °/₀₀ at 5 m, 27 °/₀₀ at 10 m, and 31 °/₀₀ at 30 m. Surface salinity remains low through September and increases in October as a result of autumn storm mixing. The strong halocline of July and August is the result of peak runoff from the large, glacial-fed streams. Runoff from the low elevation, forested watersheds does not affect surface salinities as much as runoff from the glacial streams. Runoff from lower elevations peaks in both the spring and the fall, but not during the summer (McLain 1969). Often in the summer silty glacial Mendenhall River water intrudes from neighboring Fritz Cove into the clearer waters of Auke Bay.

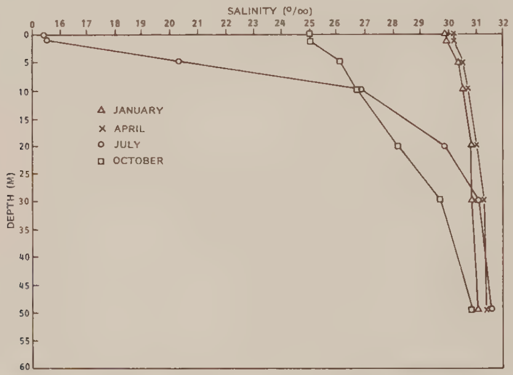


Figure 9.—Typical profiles of salinity (°/₀₀) in Auke Bay, Alaska, for January, April, July, and October; data are averages for 1960-68.

Density

Water density, a function of temperature and salinity, is used to identify water masses and to assess the stability or stratification and probable circulation of these water masses. Over the range of values observed in Auke Bay density is affected more by salinity variation than by temperature variation.

The annual cycle of water density of Auke Bay from 1960 to 1968 expressed in terms of σ_t[3] is shown in Figure 10. The density of the surface water in Auke Bay varied over a range of σ_t values between 9 and 24. Density was greatest and varied little with depth from December to April. In late April, density began to decrease at the surface and continued to decrease through July, reachi minimum in August (mean minimum σ_t = 11.0). change in σ_t occurred progressively later with incre depths (Fig. 10). The minimum σ_t at 30 m was 2 October. At 50 m the density was relatively constant had no obvious maximum or minimum.

Figure 11 shows the seasonal vertical profil average σ_t. From January to April the water in Auk is well mixed and the density is uniform from the face to 50 m. From July to October there is a strong

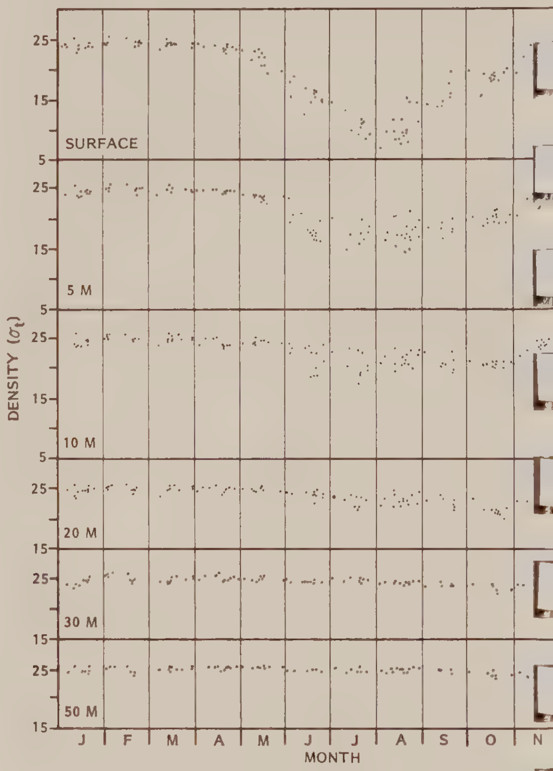


Figure 10.—Observed densities (as σ_t) at selected depths i Bay, Alaska, 1960-68.

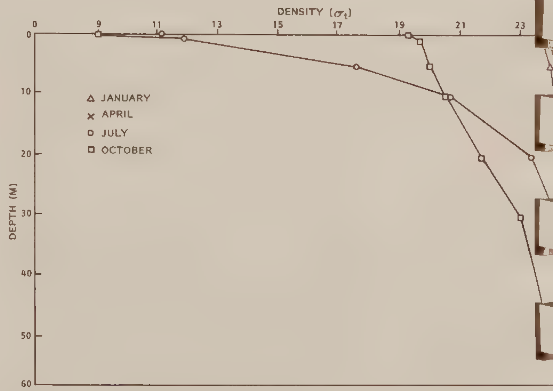


Figure 11.—Typical profiles of density (as σ_t) in Auke Bay, for January, April, July, and October; data are averages for

---

[3] Sigma-t (σ_t) = 1,000 (ρ-1) where ρ is the density of the water.

gradient from the surface down to 30 m. The data for years of this study show the same seasonal pattern of ity distribution.

ability

ability of a water column[4] is determined by the rate hange of density with depth, the vertical gradient of nsity. Where stability is high, vertical movement and ical mixing are inhibited. The water column in a ng vertical gradient of density (a marked pycnocline) ery stable, and much more energy is required to dis- ce particles of water upward or downward than in a n where the gradient is weak. This mechanism tly restricts the vertical transfer of water from the p layer to the upper layer in Auke Bay. Tidal-in- ed turbulence is unable to penetrate the pycnocline.

ble 1 gives numerical values for the stability of Auke water during July and August 1965. All the stability ues in Table 1 are positive and relatively high, in- ting a highly stable water column. Data from other s show the same general density distribution as in ; all depict a highly stable water column during the mmer. The similarity between seasonal cycles of ity and density in Auke Bay (Figs. 8 and 10) is ex- ed because of the strong dependency of density on nity at the relatively low temperatures common in ke Bay.

e development of a stable water column is one of the t ecologically significant features of the anography of Auke Bay because stability of the water column is a prerequisite for the onset of spring phytoplankton bloom (Riley 1942; Sverdrup 1953; Steele 1966). Gilmartin (1964) found that seasonal variability in the stability of the water column in a British Columbia fiord was the primary factor controlling phytoplankton growth. We observed a strong burst of phytoplankton growth each year in April or early May as solar radiation increased and a stable water column began to form. It is clear that stratification has a pronounced effect on the basic productivity of Auke Bay throughout the spring-summer growing season.

Dissolved Oxygen

Oxygen is one of the common gases dissolved in natural waters and is critically important because of its key role in biological energy transfers. Although aquatic organisms respire efficiently at oxygen concentrations considerably below saturation values, metabolic rates and efficiencies are dependent on the availability of dissolved oxygen. Consequently, the dissolved oxygen concentration is a major determinant of the environmental quality of water. The oxygen requirement of organisms is given generally in terms of absolute concentration expressed in appropriate units such as ml/liter or mg/liter.

Concentrations of dissolved oxygen at selected depths in Auke Bay are shown in Figure 12. Dissolved oxygen in the upper 5 m generally remained above 6 ml/liter, and spring and summer concentrations were above 8 ml/liter. Highest concentrations occurred from April through June and maximum observed value was 11.4 ml/liter. Below 10 m the concentration of dissolved oxygen decreased with depth. In winter the concentrations varied less with depths. The lowest concentrations of oxygen at or near the bottom occurred in September and October.

The degree of oxygen saturation provides information on the relative intensities of processes which affect the oxygen content of the water. Supersaturation is observed frequently and is essentially a result of high photosynthetic activity by plants in the upper layer of the water. Under conditions of high solar radiation during the day and abundant nutrients, the rate of oxygen production may exceed the rate at which oxygen is given

Table 1.—Stability (E)[1] at Auke Bay monitor station in July and August 1965.

	21 July 1965				10 August 1965			
Depth (m)	Temp. (°C)	Salinity (°/₀₀)	σ_t	10^6E	Temp. (°C)	Salinity (°/₀₀)	σ_t	10^6E
0	13.48	16.30	11.94		16.55	16.30	11.37	
				1,107				1,189
10	7.84	29.50	23.01		7.98	29.85	23.26	
				151				101
20	5.82	31.10	24.52		6.21	30.85	24.27	
				49				43
30	4.76	31.57	25.01		5.66	31.30	24.70	
				16				22
50	4.28	31.90	25.32		4.70	31.72	25.13	

[1]See text footnote 4.

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pths to 100 m, stability (E) can be expressed by

$$E = 10^{-3}\frac{d\sigma_t}{dZ}$$ (Sverdrup et al. 1942, p. 417),

fferent form

$$E = 10^{-3}\frac{(\sigma_{t_2} - \sigma_{t_1})}{(Z_2 - Z_1)}$$

Z = depth

$dZ \cong Z_2 - Z_1$ = change in depth

$d\sigma_t \cong (\sigma_{t_2} - \sigma_{t_1})$ = change in σ_t

$\sigma_t = 1{,}000(\rho - 1)$ where ρ = density of the water.

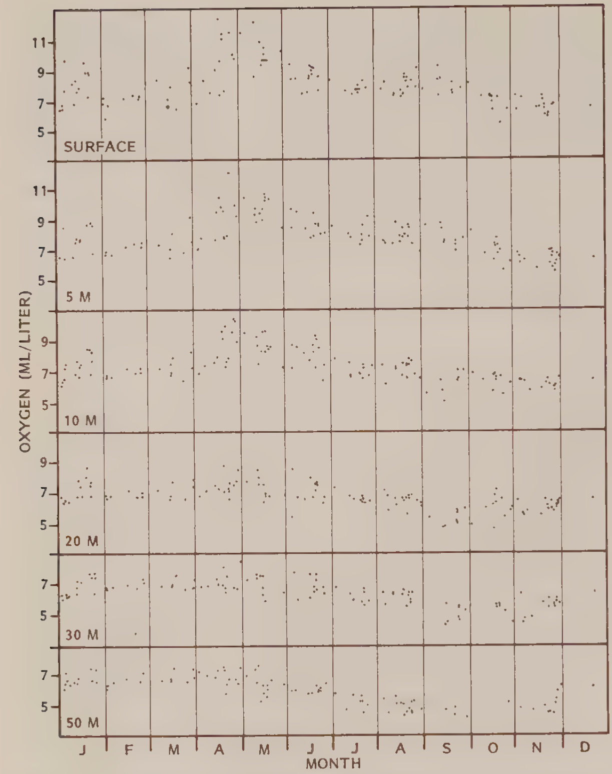


Figure 12.—Observed concentrations of dissolved oxygen (ml/liter) at selected depths in Auke Bay, Alaska, 1960-68; data are observed concentrations.

off at the surface, and supersaturation will occur. Appreciable supersaturation occurs in Auke Bay during the spring and summer, even down to 10 to 20 m (Fig. 13). This coincides with spring and summer phytoplankton blooms. Lowest concentrations of oxygen occur during the fall and winter when photosynthetic activity is reduced and bacterial decomposition and chemical oxidation of detritus lower the oxygen content.

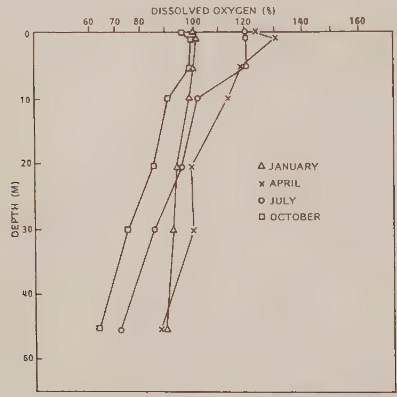


Figure 13.—Typical vertical profiles of percent saturation of dissolved oxygen in Auke Bay, Alaska, for January, April, July, and October; data are averages for 1960-68.

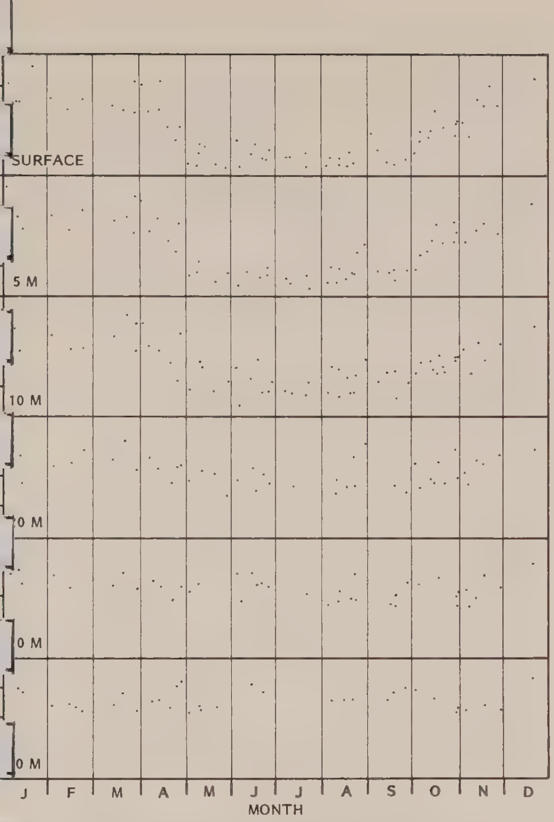
Inorganic Nutrients

The circulation of biologically active materials suc
phosphate, silicate, and nitrate, as well as their
tribution in the water column, depends on biological ar
physical processes and differs in detail from the c
culation and distribution of water and its conserv
properties. Because these materials are dissolved c
ponents of water, they are affected by advective ar
eddy diffusion processes. In addition, they are
changed between the water and the biomass in a c
process. During periods of high biological acti
changes in the distribution and abundance of biologica
ly active components of the water column may o
rapidly relative to changes due to physical proc
alone. Thus, their study may add significantly to t
physical description of an area.

During our study in Auke Bay, there was a reg
seasonal cycle in concentrations of inorganic phosp
silicate, and nitrate (Figs. 14, 15, 16). Maximum co
centrations of all three nutrients occurred in wint
(January-April), and all were uniformly distrib
throughout the water column in this period. A r
reduction of the three nutrients above 20 m in April w
associated with the outburst of phytoplankton growt
each year of our study, we noticed a marked rise in n
bers of diatoms and chlorophyll concentrations a
corresponding drop in concentrations of phospha
silicate, and nitrate (unpublished data on file N
west and Alaska Fisheries Center Auke Bay Laborat
Once stability is established in spring, high levels
photosynthetic activity rapidly deplete the availal
nutrients because vertical advection of nutrients int
surface is inhibited by the stability of the water colu

Raymont (1963) reviewed the distribution and amou
of phosphate, silicate, and nitrogen throughout the wo
oceans, including many of the important coastal ar
shore areas. In comparison with other nutrien
coastal and inshore environments, the amounts of th
materials in Auke Bay water were relatively high. F
Harbor in western Washington had some of the hi
observed concentrations of both phosphate
nitrate—about 1.8 μg-at./liter of phosphate and 21.0
at./liter of nitrate (Raymont 1963). Riley and Co
(1956) found maximum phosphate and nitrate co
trations in Long Island Sound of 1.9 and 17.0 μg-at./li
respectively. Maximum concentrations in Auke Bay w
3.5 μg-at./liter of phosphate and 26.0 μg-at./lit
nitrate. Maximum silicate concentrations in Auke
were also comparatively high—70.0 μg-at./liter. Thi
significantly greater than the maximum values repor
for the English Channel, 5.0 μg-at./liter, or for F
Harbor, 53 μg-at./liter (Raymont 1963). The hi
silicate concentration reported anywhere was 160
at./liter in the deep water of the North Pacific O
(Raymont 1963).

In general, throughout the summer, phosphate va
in Auke Bay in the upper 5 m tended to remain low
though there were some fluctuations. Minimum co
trations of phosphate observed in surface water



e 14.—Observed concentrations of inorganic phosphate (μg-at./ liter) at selected depths in Auke Bay, Alaska, 1963-67.

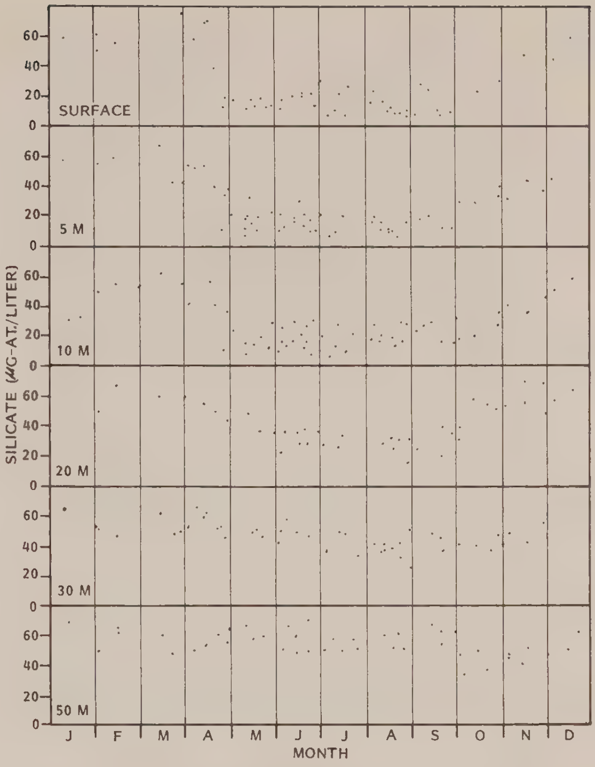


Figure 15.—Observed concentrations of dissolved silicate (μg-at./ liter) at selected depths in Auke Bay, Alaska, 1963-67.

een 0.30 and 0.20 μg-at./liter, versus a winter high of o 3.5 μg-at./liter (Fig. 14).

Short-term increases in phosphate concentrations in top 5 m from May through August did not have a g coincidence with periods of increased runoff. ce, freshwater input was discounted as a significant use of increases in nutrients, including phosphate, over t time periods (3 to 7 days). Studies by Curl, Iver- and Conners[5] showed that tidal effects in Auke Bay not sufficient to mix nutrient-rich water into the hotic zone, but that wind-induced mixing through pycnocline could be caused by winds of 4 m/s per- g for 24 h or longer.

Although the causes of fluctuation in phosphate levels not clear, the most probable causes are regeneration organic phosphate from organically bound phos- e and wind-induced vertical mixing of inorganic osphate through the pycnocline. Laboratory asurements of the rate of phosphate regeneration per 1935) indicate that up to one-half of the total phorous content of decomposing plankton appears soluble form within 24 h.

The silicate cycle in Auke Bay (Fig. 15) generally paralleled the phosphate cycle; this similarity was also demonstrated by Richards (1958) in the western Atlantic. Studies in the English Channel by Atkins (1930) showed that silicate was depleted and regenerated simultaneously with phosphate.

While phosphate and silicate in Auke Bay had the same general seasonal patterns of distribution, some differences appear when the data are examined in detail: short-term variation in concentration of phosphate occurred primarily in the upper 5 m of the water column (Fig. 14); the greatest variations in silicate occurred between 10 and 20 m (Fig. 15). Variability in the concentration of silicate throughout the water column in Auke Bay is generally greater than it is for phosphate.

Minimum silicate concentrations of 2 to 4 μg-at./liter occurred in the surface water of Auke Bay during July, August, and September (Fig. 15). Short-term increases occurred in late June and early July, when the proportion of dinoflagellates (phytoplankton which do not utilize silicate) to diatoms was quite high. We interpreted this increase as a reflection of the difference in rate of uptake by the relatively small number of diatoms present and the rate of in situ regeneration, plus advective input.

Maximum silicate concentration of about 60 μg-at./liter occurred throughout the water column from December through the middle of March—a high concentration even for inshore waters. Offshore waters usually contain an order of magnitude less silica, although the level is quite variable.

---

[5] Curl, H. C., Jr., R. L. Iverson, and H. B. O'Conners, Jr. 1971. Pela- ecology of biological production in Auke Bay, Alaska. Final report to hal Marine Fisheries Service, Auke Bay Fisheries Laboratory, Auke laska, Contract 14-17-0005-207.

The nitrate cycle in Auke Bay paralleled in general the phosphate and silicate cycles. Maximum concentrations of 24 to 28 μg-at./liter were present throughout the water column during the winter period (Fig. 16). The reduction of nitrate in the top 5 m from 24-28 μg-at./liter to 0.5 μg-at./liter with the outburst of phytoplankton growth in April is more drastic than in phosphate and silicate.

The short-term fluctuations that occurred in concentrations of phosphate and silicate did not occur in nitrate concentrations. The top 5 m were essentially depleted of nitrate by May and remained impoverished through August. We attribute this to a slow regeneration rate of nitrate from organic combinations, which according to the experiments by Brand and Rakestraw (1941) requires 3 or 4 mo. Riley (1967) presented indirect evidence that the nitrogen cycle is significantly slower than the phosphate cycle.

The summer pycnocline is enough of a barrier to prevent nitrate from reaching the surface in any significant quantity (this is true also for phosphate and silicate), except during periods when wind velocity is at least 4 m/s for at least 24 h. Periodic measurements of the nitrate content of fresh water entering Auke Bay show that only negligible amounts of nitrate enter the bay from these sources.[6]

SUMMARY

This study has described temporal variation in oceanographic conditions over an 8-yr period and provides background information on environmental variability for future detailed studies of the ecology of Auke Bay. Salient environmental features of an annual cycle in Auke Bay are summarized below.

Auke Bay is about 130 km from the open ocean and is relatively isolated from direct oceanic moderation and from major circulation patterns of the main passages and straits in southeastern Alaska. The bay is strongly influenced by land runoff and by the local climate. The annual oceanographic cycles closely follow local atmospheric cycles.

By the end of the second week in April, the water column began to stratify because of increased absorption of solar radiation in the upper 5 m and the accumulation of fresh water on the surface from increased runoff and precipitation. As the spring-summer season progressed, stratification increased until a strongly developed pycnocline essentially isolated the upper 12 to 20 m from the deeper water.

Full development of the brackish surface layer in Auke Bay occurred in late July or August. In September, cooling of surface water coupled with wind mixing due to fall storms broke the density stratification developed during the spring-summer period. Nutrient-rich water belo
pycnocline was mixed into the euphotic zone to reple
the nutrient-impoverished surface water, and a f
phytoplankton bloom occurred.

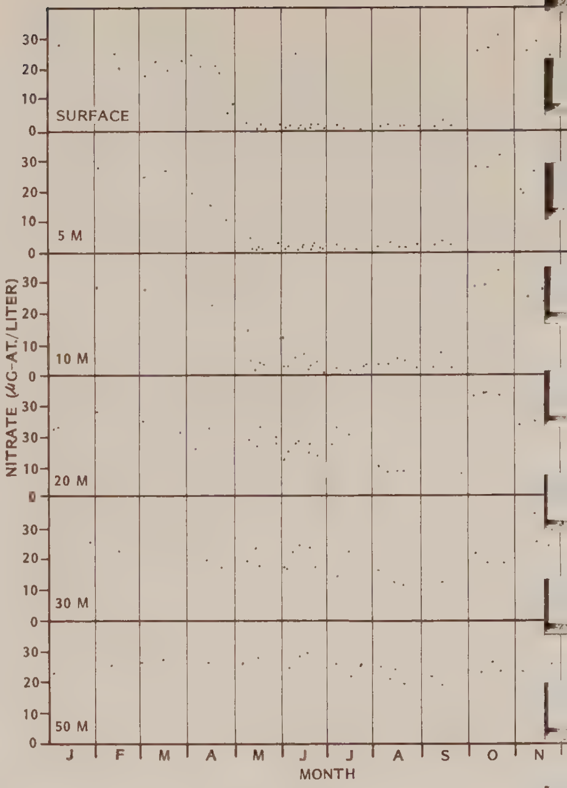


Figure 16.—Observed concentrations of dissolved nitrate (μ liter) at selected depths in Auke Bay, Alaska, 1963-67.

As the season progressed into fall, decrea
temperatures and increasing salinities in the su
layer of water increased the density of the surface wat
resulting in thermohaline circulation which thorou
mixed the water column. Hence, during the winter
water column was essentially homogeneous, and the co
centrations of phosphate, silicate, and nitra
throughout the water column were high. A well-m
water column and low solar radiation prevented any
nificant phytoplankton growth during the winter; co
sequently, the distribution of biologically active
solved components depended almost totally on phy
processes during the winter.

The seasonal pattern described was repeated each ye
during the 8-yr period that routine observations
made.

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NOAA Technical Report NMFS SSRF-713

Current Patterns and Distribution of River Waters in Inner Bristol Bay, Alaska

Richard R. Straty

June 1977

U.S. DEPARTMENT OF COMMERCE
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Current Patterns and Distribution of River Waters in Inner Bristol Bay, Alaska[1]

RICHARD R. STRATY[2]

ABSTRACT

Hydrographic studies to determine the distribution of the waters of the major sockeye-salmon-producing river systems in inner Bristol Bay show the net seaward flow of river water is along the northwest (right) side of inner Bristol Bay. The net motion of seawater toward the head of Bristol Bay transports with it the waters of Ugashik and Egegik rivers, which enter the bay on the southeast side. Near Egegik Bay to Middle Bluff, the mixed sea and river waters join the seaward flow of Kvichak and Naknek river waters, which enter at the head of Bristol Bay. Waters of these four rivers, along with the large volume of water from the rivers entering Nushagak Bay, are eventually transported to, and move seaward on, the northwest side of Bristol Bay. Waters of Naknek, Egegik, and Ugashik rivers are similar to each other in the courses followed during ebb and flood tides. Flood tide currents, along with the nontidal current, transport water from Egegik and Ugashik rivers above or north of the entrance to Egegik and Ugashik bays.

INTRODUCTION

ne distribution and migratory behavior of juvenile adult sockeye salmon, *Oncorhynchus nerka*, while in Bay are influenced by physical and chemical ties of the bay. The literature on salmon behavior cates that certain features of a bay or estuary, such alinity gradients (McInerney 1964), or phy- mical properties of home-river waters (Hasler and 1951; Wisby and Hasler 1954; Donaldson and 1958; Hara et al. 1965; Hasler 1966), may provide ve cues to salmon during their seaward and hom- grations. In Bristol Bay, the distribution of home- waters and the physicochemical properties they ain are the result of ocean currents.

onjunction with investigations by the National Fisheries Service of the early marine life of eye salmon (Straty 1974) and their later dis- tion during spawning migration (Straty 1975), data ollected to describe the current patterns and dis- on of waters from the major sockeye-salmon- ucing river systems in Bristol Bay. Such infor- on was expected to provide a better understanding relationship between environmental factors and or of salmon while in Bristol Bay and to provide ledge for predicting the distribution of pollutants might be introduced into the bay or rivers during tical period when salmon are present.

his paper I describe the distribution of water from major river system as it flows out of the bay and describe current patterns of the mixed sea and river waters within the bay.

BACKGROUND

Bristol Bay, the southeastern terminus of the shallow continental shelf of the Bering Sea, is considered to be the area east of a line drawn from Cape Sarichef on Unimak Island to the Kuskokwim River (Fig. 1). Unimak Island and the Alaska Peninsula bound Bristol Bay on the south and east and separate it from the North Pacific Ocean. The studies reported here were conducted in the inner bay between Kvichak and Cinder rivers (Fig. 1).

Most of the precipitation in Bristol Bay occurs from July through September. Total rainfall varies from 76.2 to 101.6 cm annually, August being the rainiest month (U.S. Coast and Geodetic Survey 1964). Mean air temperature is about 1.7°C. Fog occurs in every month of the year at most localities. Ice begins to form along shores of the bay in October or November and expands seaward until March. Although the ice pack usually begins to break up and melt in April, compact fields of drift ice may remain offshore until late May. Over much of Bristol Bay, winds are from the northeast from October to March and from the southeast in spring, summer, and early fall. Average wind velocity is 15 knots at Port Heiden in outer Bristol Bay and about 10 knots at Naknek at the head of the bay.

Movement of water in Bristol Bay is affected by ice, runoff, winds, tidal currents, density gradients, and movement of oceanic water off the continental shelf. The funnel-shaped configurations of the bay and of the river entrances create tidal currents with velocities up to 6 knots. Tides and currents in the bay are the mixed type in which two highs and two lows occur during a tidal day, generally with a significant diurnal inequality. The diurnal range of tide averages about 5.5 m at river entrances.

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in part on a thesis submitted to the graduate school of Oregon University, Corvallis, in partial fulfillment of the requirements for gree of Doctor of Philosophy, June 1969.

west and Alaska Fisheries Center Auke Bay Laboratory, Na- arine Fisheries Service, NOAA, P.O. Box 155, Auke Bay, AK

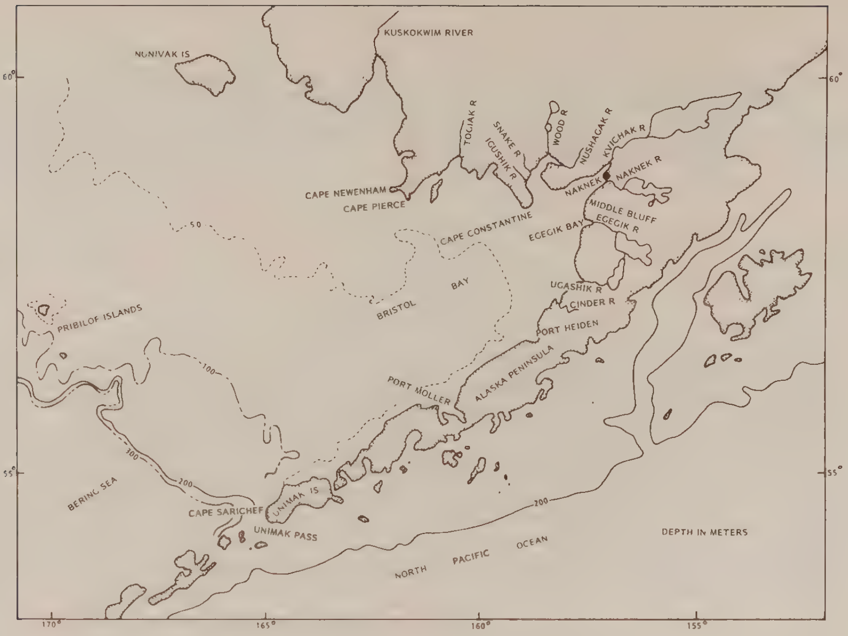

KUSKOKWIM RIVER
NUNIVAK IS
60°
60°
TOGIAK R
SNAKE R
IGUSHIK R
WOOD R
NUSHAGAK R
KVICHAK R
NAKNEK
NAKNEK R
CAPE NEWENHAM
CAPE PIERCE
MIDDLE BLUFF
EGEGIK R
EGEGIK BAY
CAPE CONSTANTINE
50
BAY
BRISTOL
UGASHIK R
CINDER R
PORT HEIDEN
PRIBILOF ISLANDS
ALASKA PENINSULA
PORT MOLLER
100
100
200
55°
55°
BERING SEA
UNIMAK IS
CAPE SARICHEF
200
UNIMAK PASS
DEPTH IN METERS
NORTH
PACIFIC
OCEAN
170°
165°
160°
155°

Figure 1.—Bristol Bay, showing locations of principal river systems.

Dodimead et al. (1963) depicted the pattern of the nontidal currents in a review of the general oceanographic conditions in Bristol Bay from May through August in 1938 and 1939. Dodimead et al. (1963) inferred from salinity and sigma-*t* distributions that water in the bay moved counterclockwise. Hebard (1959) determined that the average velocity of this current near Port Moller (Fig. 1) on the Alaska Peninsula was slightly less than 0.1 knot, or about 2 n.mi./day.

In spring (May and June) a temperature front occurs in the seawater across the bay and separates waters of the inner bay from those of the outer bay. In 1939 this front occurred along a line from Port Heiden to Cape Pierce; surface temperatures and salinities indicated the presence of counterclockwise gyres both shoreward and seaward of this front (Dodimead et al. 1963). The inshore gyre was apparently confined to the surface, and warm dilute river runoff was contained eastward of Cape Pierce and forced to recirculate shoreward of this front. By August the temperature front had disappeared, and a peripheral counterclockwise flow was evident throughout the bay.[3] These descriptions of water movement apply to the area seaward of a line between Cape Constantine and Egegik Bay (Fig. 1).

DISTRIBUTION OF RIVER WATERS

Three methods were used to determine the distribution of waters from individual river systems in inner Bristol Bay: 1) measuring vertical and horizon tributions of salinity, 2) tracking river waters tagged a fluorescent dye, and 3) tracking drift cards rele strategic locations in the bay.

Four Bristol Bay river systems were studied—Na Kvichak, Egegik, and Ugashik (Fig. 1). These sys were chosen because their average combined pro of sockeye salmon is more than 70% of the total Bristol Bay run. Moreover, a considerable amount shore mark-and-recovery data were available for salmon of stocks occurring along the southeast sid inner bay where these rivers enter.

Determining Salinity Distribution

Salinity was measured in 1966 at stations alor parallel transect lines across inner Bristol Bay. stations were located at 8-km intervals along shore transect lines, which were 16 km apart, and and 3.2-km intervals along inshore transect lines, were 8 km apart. Salinity was measured with a man Model RS5-3 electrodeless induction salinon the surface and at 1- and 2-m intervals thereafter bottom at low tide and usually during the following tide.

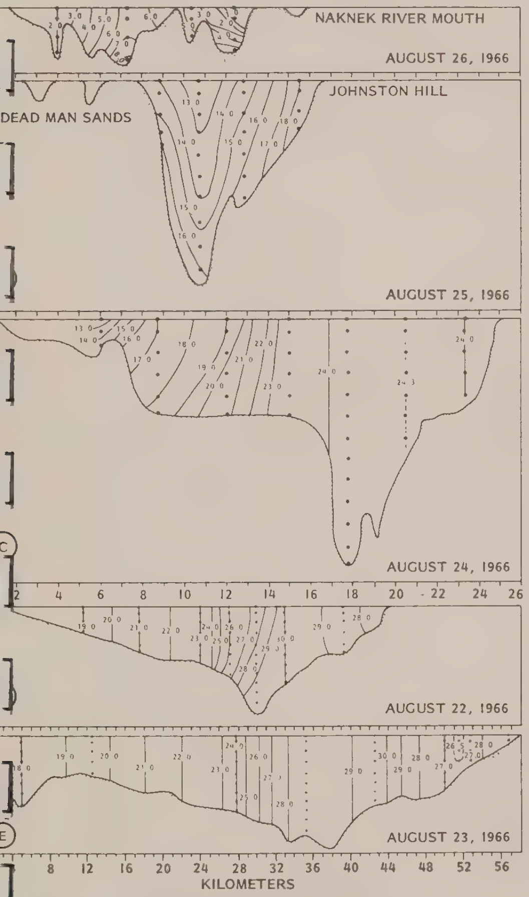
Data were collected on consecutive days in la and August during periods when tidal conditions w nearly similar as possible. Although transects coul always be run on the desired tide because of inc weather and darkness, they could usually be run lowest and highest tides of the day. Coverage transect line usually began between 1 and 1½ h low or high tide. The tracking vessel was kept on stant compass course along a given transect lin led between stations so that it moved toward the of the bay or seaward at a rate controlled by the of the tidal current. In this way the vessel was as- to remain in water representative of water at the ning of a transect run.

---

[3] Recent data collected by the National Marine Fisheries Service, which are on file at the Auke Bay Laboratory, Auke Bay, Alaska, suggest that a temperature front occurs annually, but its location may vary from year to year.

sects were usually run when the wind velocity was 5 knots; speeds greater than 13 knots caused waves come unstable and break into whitecaps, resulting increase in the mixing of the surface waters (John- 60).

vertical and horizontal profiles of salinity in inner l Bay are used to interpret distribution of river s in the inner bay where there is very little vertical on in salinity (Fig. 2). Vertical mixing is caused by



2.—Vertical profiles of salinity (‰) at 16-km intervals across inner Bristol Bay, August 1966.

gh velocities of the tidal current, shallow depth, wind. Salinity in inner Bristol Bay varied horizon- as shown by surface and bottom salinities at low gh tides (Figs. 3-6); salinity was low on the north- ide and high on the east side. Dodimead et al.) found that this condition persisted farther off- : low-salinity water moved seaward on the north- side of the bay, and a countercurrent of high- y water was present on the southeast side. This current appeared as a wedge of high-salinity water between the river waters entering each side of the bay.

Dye Studies

To track water from individual rivers, I used a tracer technique utilizing a fluorescent organic pigment, Rhodamine B (alkyl aminophenol derivative).[4] This technique was first used by Pritchard and Carpenter (1960) to observe the movement and dispersion of water in various parts of Chesapeake Bay.

Ideally, a tracer is released into a river when a continuous flow is expected for a period of time long enough for the tracer to achieve equilibrium with its environment. However, the objectives of my study could be met by instantaneous release of enough Rhodamine B to trace its course over one or two tidal cycles. The dye was released only on days when wind velocities were less than 15 knots because the wind is considered to be an important agent of mixing and dispersion of a tracer in short-term studies such as mine. The dye was rapidly poured from plastic containers into the propeller wash of the tracking vessel while traveling at a speed of 5 knots. Approximately 9.5 to 18.9 liters of dye were released about 1 h after high slack tide along a continuous line 3 m wide across the main channel of the river. The channel was crossed three or four times with a line of dye laid down about 15 m upstream from the previous line. The dye mixed rapidly with the water to a depth of 2 m; within 1 h after release it had mixed to a depth of 4 m. Usually within 1 h, individual lines of dye had diffused horizontally and merged with one another, producing a visible patch across the channel 60 m or more wide. Dye was also released in a similar manner near the end of the ebb tide offshore across the course assumed by the dye previously released at the beginning of the ebb tide. The course of this release was followed during the following flood tide.

Paths of Fluorescent Dye.—Dye was released into Naknek, Egegik, and Ugashik rivers in July and August 1965 and 1966. No dye was released in the Kvichak River because the course and distribution of Kvichak River water in inner Bristol Bay could be logically deduced from results of the Naknek River study and the surveys to measure salinity. The tracks of 11 dye releases in the three rivers showed that river waters followed rather discrete and similar courses in the inner bay (Figs. 7, 8). The course of dye released near the end of ebb tide at the mouths of the three rivers indicated that a portion of the river water was carried north by the succeeding flood tide (Fig. 8). Water entering the bay from these rivers (and Kvichak River) near the end of ebb tide constitutes the greatest fraction of river water entering the bay during a tidal cycle. In most cases, dye was tracked on the flood

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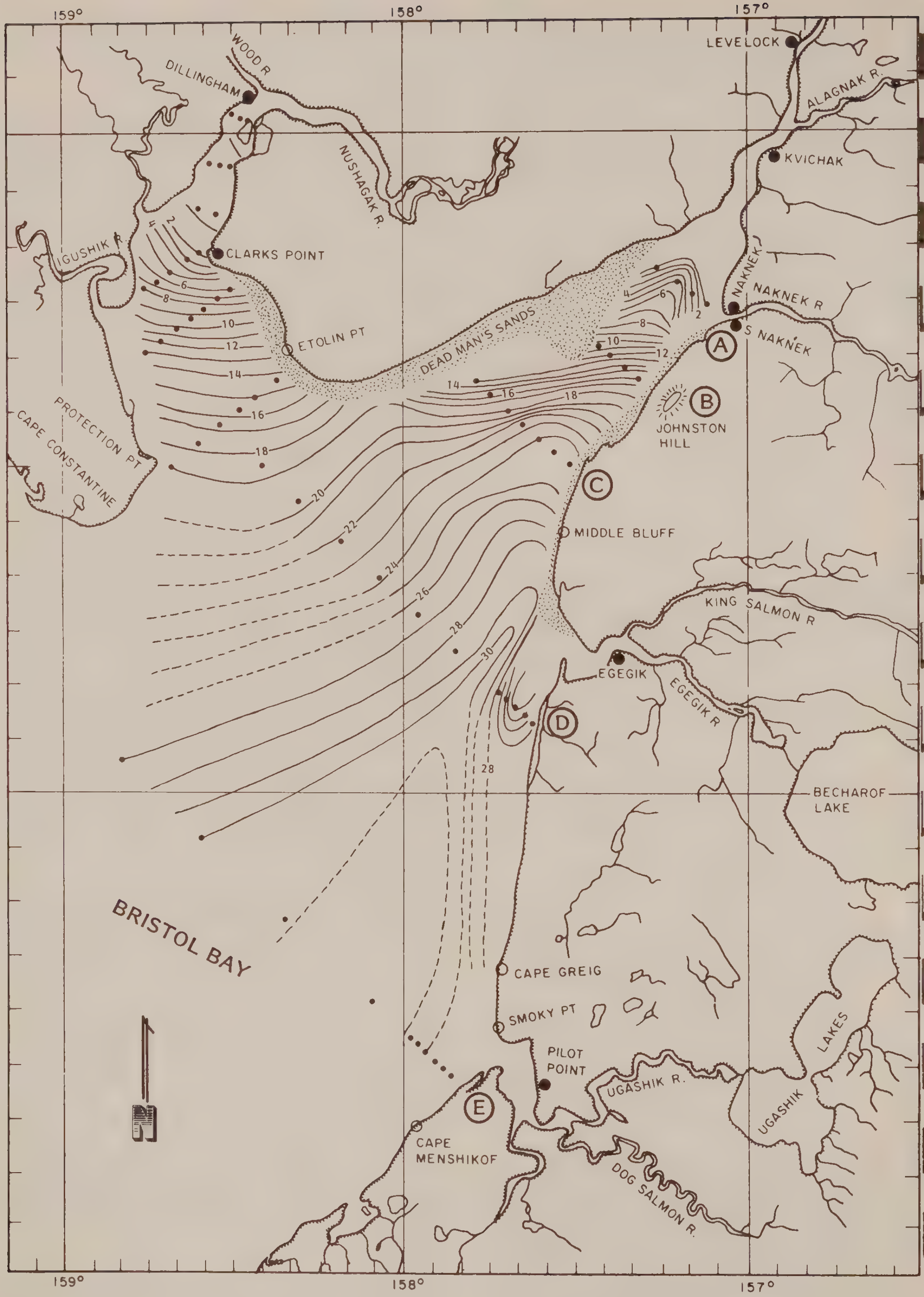
[4] Rhodamine B dye was purchased as a 40% (by weight) acetic acid solution. Because the density of the solution was greater than that of the water into which it was to be released, its specific gravity was adjusted to 1.00 by the addition of methyl alcohol.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158°
157°
WOOD R
DILLINGHAM
NUSHAGAK R.
LEVELOCK
ALAGNAK R.
KVICHAK
IGUSHIK R
CLARKS POINT
NAKNEK
NAKNEK R
S NAKNEK
ETOLIN PT
DEAD MAN'S SANDS
A
B
JOHNSTON HILL
C
MIDDLE BLUFF
PROTECTION PT
CAPE CONSTANTINE
KING SALMON R
EGEGIK
EGEGIK R
D
BECHAROF LAKE
BRISTOL BAY
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK R.
UGASHIK LAKES
E
CAPE MENSHIKOF
DOG SALMON R.
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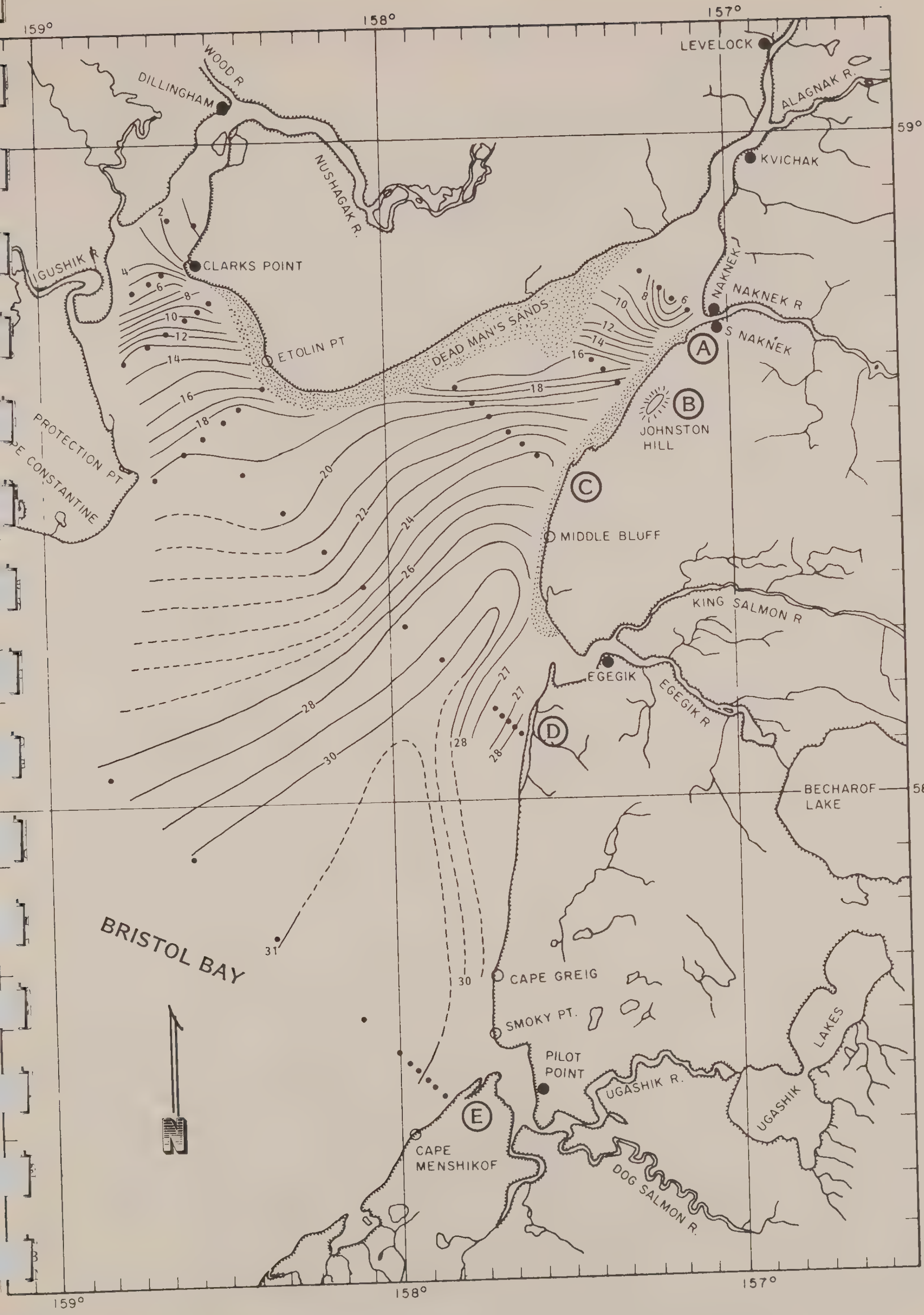
Figure 3.—Surface salinity (‰) at low tide, inner Bristol Bay, July and August 1966.


159°
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WOOD R
DILLINGHAM
NUSHAGAK R.
LEVELOCK
ALAGNAK R.
KVICHAK
IGUSHIK R
CLARKS POINT
ETOLIN PT
DEAD MAN'S SANDS
NAKNEK
NAKNEK R
S NAKNEK
A
B
JOHNSTON HILL
C
MIDDLE BLUFF
PROTECTION PT
CAPE CONSTANTINE
KING SALMON R
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BECHAROF LAKE
BRISTOL BAY
CAPE GREIG
SMOKY PT.
PILOT POINT
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DOG SALMON R.
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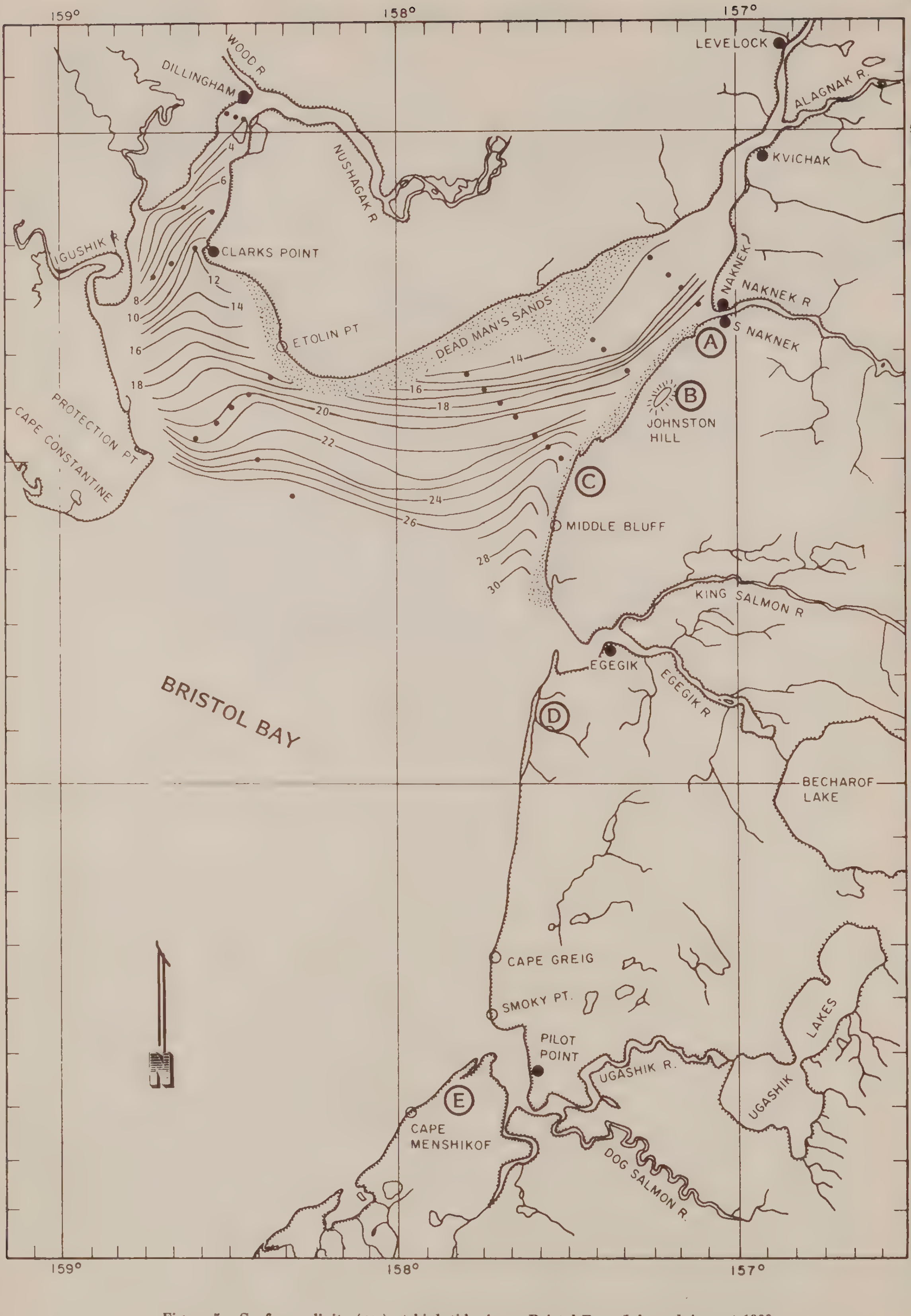
Figure 4.—Bottom salinity (‰) at low tide, inner Bristol Bay, July and August 1966.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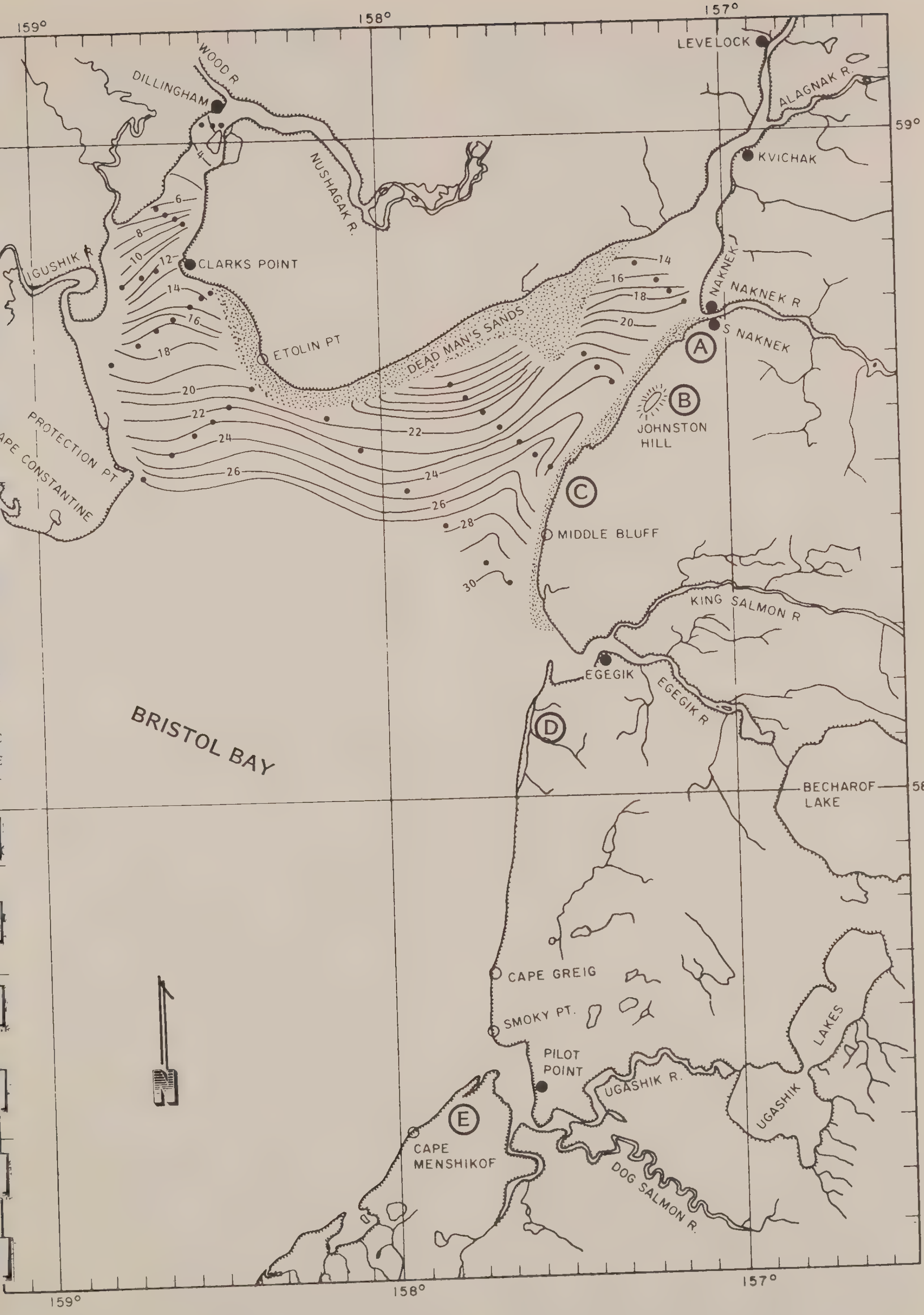
158°
157°
LEVELOCK
WOOD R
DILLINGHAM
ALAGNAK R.
NUSHAGAK R
KVICHAK
4
6
IGUSHIK R
CLARKS POINT
NAKNEK
NAKNEK R
12
8
14
10
DEAD MAN'S SANDS
S NAKNEK
ETOLIN PT
A
16
14
16
18
B
JOHNSTON HILL
PROTECTION PT
18
20
CAPE CONSTANTINE
22
C
24
26
MIDDLE BLUFF
28
30
KING SALMON R
EGEGIK
EGEGIK R
BRISTOL BAY
D
BECHAROF LAKE
CAPE GREIG
SMOKY PT.
PILOT POINT
UGASHIK R.
LAKES
UGASHIK
E
CAPE MENSHIKOF
DOG SALMON R.
N
159°
158°
157°

Figure 5.—Surface salinity (‰) at high tide, inner Bristol Bay, July and August 1966.


159°
158°
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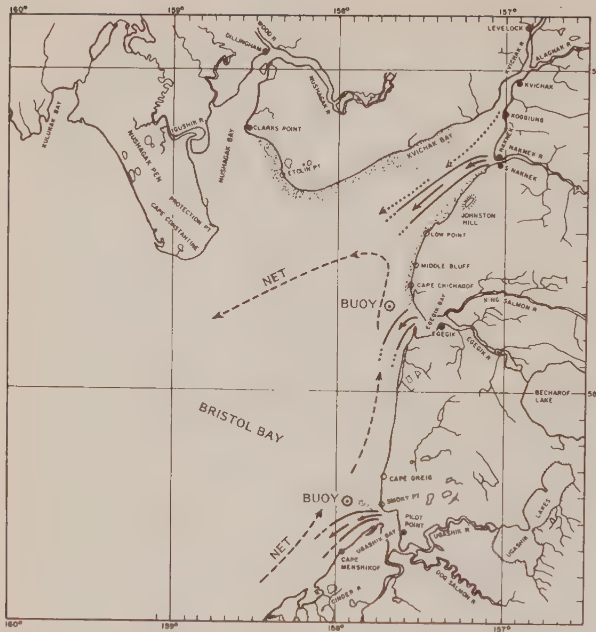
58°
LEVELOCK
ALAGNAK R.
WOOD R
DILLINGHAM
NUSHAGAK R.
KVICHAK
IGUSHIK R
CLARKS POINT
ETOLIN PT
DEAD MAN'S SANDS
NAKNEK
NAKNEK R
S NAKNEK
A
B
JOHNSTON HILL
C
MIDDLE BLUFF
PROTECTION PT
CAPE CONSTANTINE
KING SALMON R
EGEGIK
EGEGIK R
D
BRISTOL BAY
BECHAROF LAKE
CAPE GREIG
SMOKY PT.
PILOT POINT
UGASHIK R.
UGASHIK
LAKES
E
CAPE MENSHIKOF
DOG SALMON R.
4
6
8
10
12
14
16
18
20
22
24
26
28
30

Figure 6.—Bottom salinity (‰) at high tide, inner Bristol Bay, July and August 1966.


160°
159°
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157°
59°
58°
LEVELOCK
WOOD R
DILLINGHAM
KVICHAK R
ALAGNAK R
KVICHAK
NUSHAGAK R
KOGGIUNG
KULUKAK BAY
IGUSHIK R
CLARKS POINT
NUSHAGAK PEN
NUSHAGAK BAY
KVICHAK BAY
NAKNEK R
NAKNEK
S NAKNEK
ETOLIN PT
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
NET
MIDDLE BLUFF
CAPE CHICHAGOF
BUOY
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
BRISTOL BAY
CAPE GREIG
SMOKY PT
BUOY
PILOT POINT
UGASHIK BAY
UGASHIK R
LAKES
NET
CAPE MENSHIKOF
CINDER R
DOG SALMON R

Figure 7.—Course of river waters in inner Bristol Bay on ebb tide as determined from course of dye releases in July and August 1965 and 1966. [Solid lines marking boundaries of river water denote area of actual observation; dotted lines indicate probable course; dashed lines indicate direction of net (nontidal) current. The direction of the net current is based on the results of previous oceanographic investigations (Dodimead et al. 1963) which showed a counterclockwise movement of water in this region.]

tide at least 4.8 km north (above) of the mouths of Naknek, Egegik, and Ugashik rivers. This water moved toward shore and over the tideflats.

The path of the dye was followed as the vessel traveled at a speed of 3 knots. The vessel's position was accurately maintained by reference to prominent landmarks, marker buoys, and bottom topography (determined by comparing fathometer readings with navigational charts of the area). Because of the low wind velocity (less than 15 knots), the only factor affecting the vessel's position was the tidal current. Dye was followed visually for about 1 to 2 h after it was released; thereafter a fluorometer (Turner Model III) was used to detect it. Continuous sampling was carried out by pumping water from a depth of 1 m through the fluorometer as the vessel moved through the water. When readings indicated no dye was present, the course was altered 180° so that the dye patch was reentered.

Corrections for background fluorescence were applied to fluorometer readings during the tracking phase of the tracer studies. These were determined by running samples of pure river water from each of the rivers to be studied through the fluorometer and recording the instrument's dial readings. In addition, waters along the course of proposed tracer releases and the offshore portion of the study area were also sampled to determine the level of possible interfering background fluorescence. Only fluorometer dial readings above these background levels were considered to indicate the presence of dye.

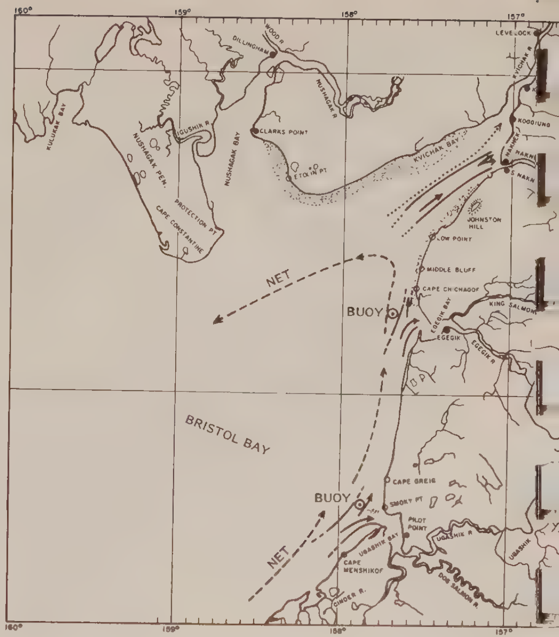

160°
159°
158°
157°
LEVELOCK
WOOD R
DILLINGHAM
NUSHAGAK R
KOGGIUNG
KULUKAK BAY
IGUSHIK R
CLARKS POINT
NUSHAGAK PEN
NUSHAGAK BAY
KVICHAK BAY
ETOLIN PT
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
NET
MIDDLE BLUFF
CAPE CHICHAGOF
BUOY
KING SALMON
EGEGIK
BRISTOL BAY
CAPE GREIG
SMOKY PT
BUOY
PILOT POINT
UGASHIK BAY
UGASHIK R
NET
CAPE MENSHIKOF
CINDER R
DOG SALMON R

Figure 8.—Course of river waters in inner Bristol Bay on flood ti determined from course of dye releases in July and August 19 1966. [Solid lines marking boundaries of river water denote actual observation; dotted lines indicate probable course; das lines indicate direction of net (nontidal) current. The direction of net current is based on the results of previous oceanographic tigations (Dodimead et al. 1963) which showed a countercl movement of water in this region.]

Shear Lines.—Shear lines caused by adjoining rents having different speeds or directions affecte distribution of dye during ebb tide. These lines, a ch teristic feature of the inner bay, were seen dur relatively calm weather. They were not present d the flood tide but reformed, usually with some l variation of the axis, during the following ebb tide. distribution of dye indicated that these lines marked boundaries between waters leaving Naknek and Kv rivers and between the offshore water flowing sea and the waters entering the bay from Egegik a Ugashik rivers. When surface turbulence was minim shear lines were observed about 6.5 km seaward fro mouth of the Naknek River. In Figure 7, the outer bo ary denoting the course of the rivers corresponds to general location of the shear lines. Dye released Naknek, Egegik, and Ugashik rivers never crossed developed shear lines. Farther offshore the shear were not well developed and the dye dispersed latera to some extent, no doubt because of decreased velo and less difference in direction of separate currents northward extent of individual river waters during tide could not be identified by shear lines (Fig. 8).

The area of Kvichak Bay not occupied by Na River water was occupied by Kvichak River water (7, 8). Kvichak River had a much greater volume of d charge than Naknek River, as indicated by the low salinity on the northwest side of Kvichak Bay (Figs. Undoubtedly, waters of these two rivers mixed a

r interface, particularly farther seaward during ebb
when current velocities were reduced. Mixing
en water masses also took place during flood tide,
vichak River water was predominant along the
hwest shore and Naknek River water along the
east shore of Kvichak Bay.

er runoff in this area moved southwest toward the
nwest side of inner Bristol Bay (Fig. 7). By the time
e waters had moved seaward as far as the Middle
area, they were more than 8 km offshore. This
nent of less saline water may be inferred also from
salinity distribution (Figs. 3, 6).

he course and distribution of Egegik River water is
early seen in the salinity distribution off the en-
to Egegik Bay (Figs. 3, 4). Salinity data were not
ined from the entrance of Ugashik Bay, but dye
s showed that the salinity pattern there should be
r to the one off Egegik Bay.

ng River Waters From Drift Cards

he drift card used in this study was developed by
tin (1967). It is made of a folded sheet (22 × 28 cm)
ernational orange plastic. A polystyrene float at-
d by galvanized staples to one end and a lead
ht attached to the opposite end keep the card ver-
in the water. The cards are serially numbered and
printed instructions to the finder and spaces for
ding requested recovery information.

n 2 June 1967, 1,007 cards were released at eight
ons along the northeast side of inner Bristol Bay
1). They were released in groups of 10 from an air-
between 1 and 2 h after high slack tide so that those
ased near river mouths and bay entrances would
immediately out into the bay.

ds were recovered in two ways: 1) I collected cards
beaches during aerial surveys conducted 6 wk or
e after the cards were released, and 2) commercial
n gill net fishermen returned cards which drifted
heir area of operation. Of the 1,007 cards released,
were recovered (Table 1). The locations of recovery
sultant directions of drift are shown in Figures 9 to
ighty-nine (8.8%) cards were recovered from
es; parts of 31 more cards were also found on beaches but were unusable because they had lost identifying serial numbers.

—**Number and percent of drift cards recovered from releases in eight areas of inner Bristol Bay, 2 June 1967.**

ease location s. 9-16)	No. cards released	Cards recovered	
		Number	Percent
hak River mouth	102	33	32.4
ek River mouth	100	44	44.0
Chichagof	150	11	7.3
Bay entrance	101	5	4.9
N	152	14	9.2
Greig	151	21	13.9
hik Bay entrance	101	4	4.0
enshikof	150	9	6.0
	1,007	141	14

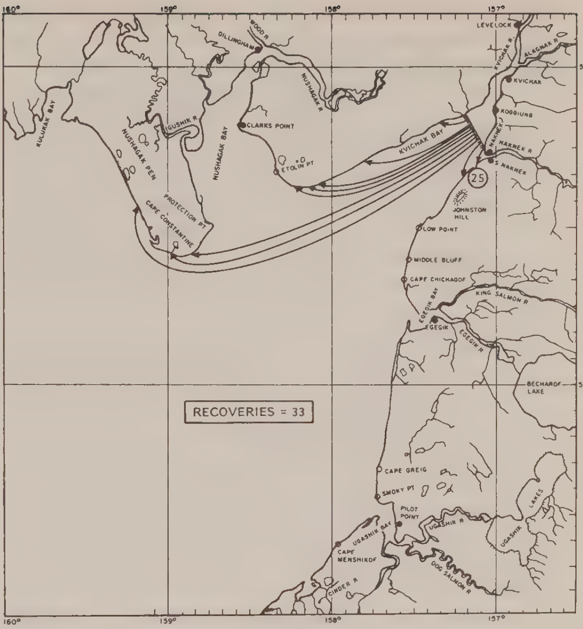

160°
159°
158°
157°
59°
58°
LEVELOCK
ALAGNAK R
KVICHAK R
KVICHAK
KOGGIUNG
NAKNEK
NAKNEK R
S NAKNEK
DILLINGHAM
WOOD R
NUSHAGAK R
KULUKAK BAY
IGUSHIK R
NUSHAGAK PEN
NUSHAGAK BAY
CLARKS POINT
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
25
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 33
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK
LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

Figure 9.—Recovery locations of drift cards released across Kvichak River mouth, inner Bristol Bay, 2 June 1967. (Lines from release site to recovery location indicate resultant direction of drift.)

The direction of drift for cards released across the mouths of the Kvichak and Naknek rivers (Figs. 9, 10) was seaward in a southwesterly direction. Most cards recovered from these two releases were found between Naknek River mouth and Johnston Hill. The concen-

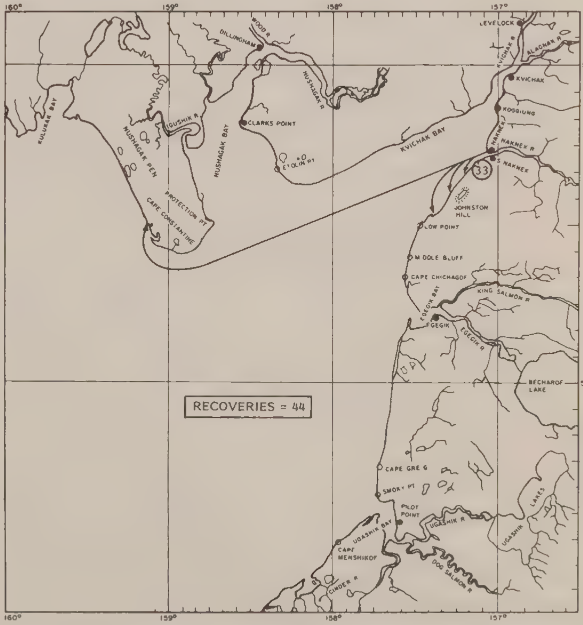

160°
159°
158°
157°
59°
58°
LEVELOCK
ALAGNAK R
KVICHAK R
KVICHAK
KOGGIUNG
NAKNEK
NAKNEK R
S NAKNEK
DILLINGHAM
WOOD R
NUSHAGAK R
KULUKAK BAY
IGUSHIK R
NUSHAGAK PEN
NUSHAGAK BAY
CLARKS POINT
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
33
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 44
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK
LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

Figure 10.—Recovery locations of drift cards released across Naknek River mouth, inner Bristol Bay, 2 June 1967. (Lines from release site to recovery location indicate resultant direction of drift.)

tration of cards in this area was probably due to several factors. Water leaving Naknek River during the first several hours after high slack water moves seaward along the southeast side of Kvichak Bay. This movement must also occur for water above the Naknek River mouth along the east side of Kvichak River. Once the water level has dropped enough, the influence of a gravel bar off the entrance to Naknek River causes the main stream of Naknek River water to be directed farther offshore, and the water moving seaward along the east side of Kvichak River is also directed farther offshore. These flows converge and cause the shear line in the Naknek River mouth mentioned earlier. The emergence of the gravel bar at ebb tide also causes an eddy seaward of the bar which extends as far as the northern end of Johnston Hill (Fig. 10). Drift cards floating into this dead-water area at a certain stage of tide may have been prevented for a time from further seaward movement, and most were recovered from 2 to 17 days after release, indicating some had been confined in the area for many tidal cycles. More than half the cards recovered in the area were taken in stationary salmon gill nets.

Drift cards released in the mouth of Kvichak River and recovered elsewhere than in the area south of the mouth of Naknek River show that the seaward flow of Kvichak River water is along the northwest side of Kvichak Bay. Other than in the limited area mentioned, no cards released in Kvichak River were recovered on the southeast side of the bay (Fig. 9).

Cards released in Naknek River were recovered along the southeast side of Kvichak Bay as far as Low Point (Fig. 10), but no Naknek River cards were found seaward of this point on this side of the bay. One was recovered, however, on the west side of Nushagak Peninsula, dicating that the route of Naknek River water is offs and toward the northwest side of inner Bristol B

Drift cards released off Cape Chichagof and t trance to Egegik Bay (Figs. 11, 12) show that moven of these waters is across and toward the northwest of inner Bristol Bay; one card from each release w covered north of the release site.

An eddy similar to the one at the Naknek River m probably exists south of Egegik River also. Most released between Egegik and Ugashik rivers were tually recovered on beaches south of Egegik Bay 13, 14).

Recoveries of cards from releases along lat. 58°N 13), off Cape Greig (Fig. 14), at the entrance to U Bay (Fig. 15), and off Cape Menshikof (Fig. 16) show course of the water to be north along the coast an timately toward the northwest side of Bristol Ba cards from any of these four releases were recove the south.

The distribution of drift cards furnished evidence on the courses followed by Kvichak, Na Egegik, and Ugashik river waters in Bristol Bay a the influence of the net or nontidal current on this tern. The course followed is consistent with the cou ferred from the horizontal salinity distribution area and from results of the tracer studies.

SYNOPSIS OF DISTRIBUTION OF RIVER WATERS

Results of the three methods of investigation pern reasonable synopsis of the distribution of waters

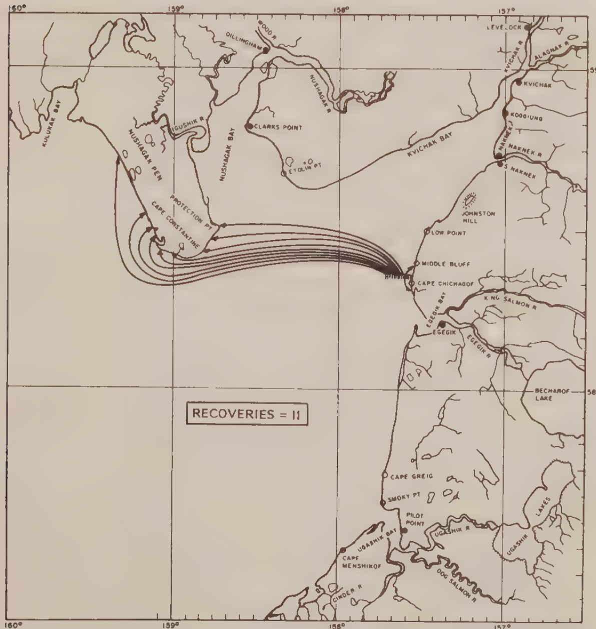

160°
159°
158°
157°
LEVELOCK
WOOD R
DILLINGHAM
KVICHAK R
ALAGNAK R
59°
KVICHAK
KOGGIUNG
NAKNEK
NAKNEK R
S NAKNEK
KVICHAK BAY
NUSHAGAK R
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
ETOLIN PT
KULUKAK BAY
NUSHAGAK PEN
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
58°
RECOVERIES = 11
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK LAKES
CAPE MENSHIKOF
CINDER R
DOG SALMON R

Figure 11.—Recovery locations of drift cards released off Cape Chichagof, inner Bristol Bay, 2 June 1967. (Lines from release site to recovery location indicate resultant direction of drift.)

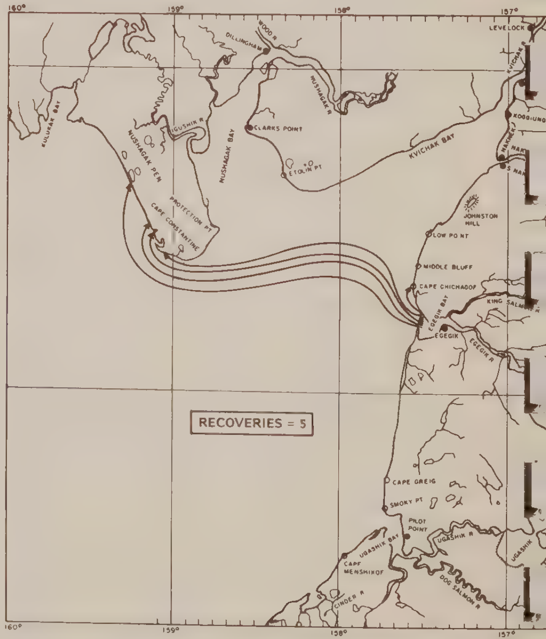
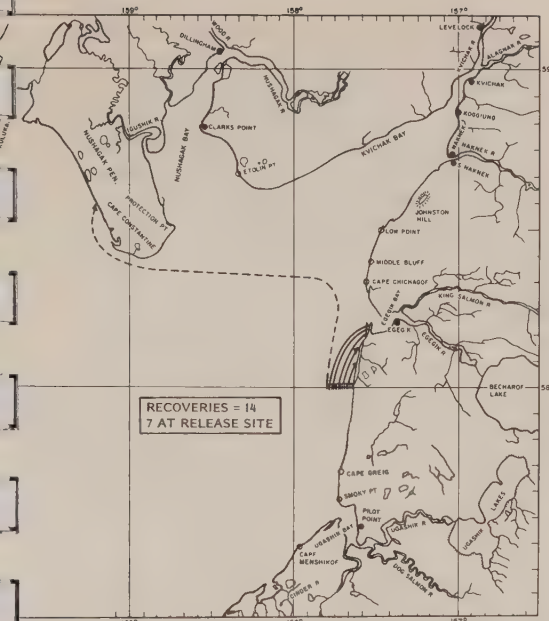

160°
159°
158°
157°
LEVELOCK
WOOD R
DILLINGHAM
KOGGIUNG
KVICHAK BAY
NUSHAGAK R
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
ETOLIN PT
KULUKAK BAY
NUSHAGAK PEN
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON
EGEGIK BAY
EGEGIK
EGEGIK R
RECOVERIES = 5
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
CAPE MENSHIKOF
CINDER R
DOG SALMON R

Figure 12.—Recovery locations of drift cards released acros trance to Egegik Bay, inner Bristol Bay, 2 June 1967. (Li release site to recovery location indicate resultant direction


159°
158°
157°
59°
58°
LEVELOCK
DILLINGHAM
WOOD R
NUSHAGAK R
KVICHAK R
ALAGNAK R
KVICHAK
KOGGIUNG
NAKNEK R
S NAKNEK
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
NUSHAGAK PEN.
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 14
7 AT RELEASE SITE
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

ure 13.—Recovery locations of drift cards released along lat. N, inner Bristol Bay, 2 June 1967. (Lines from release site to ery location indicate resultant direction of drift.)

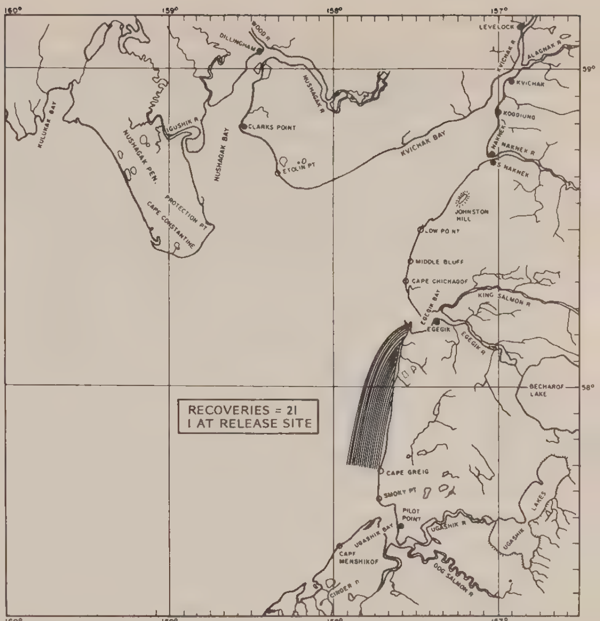
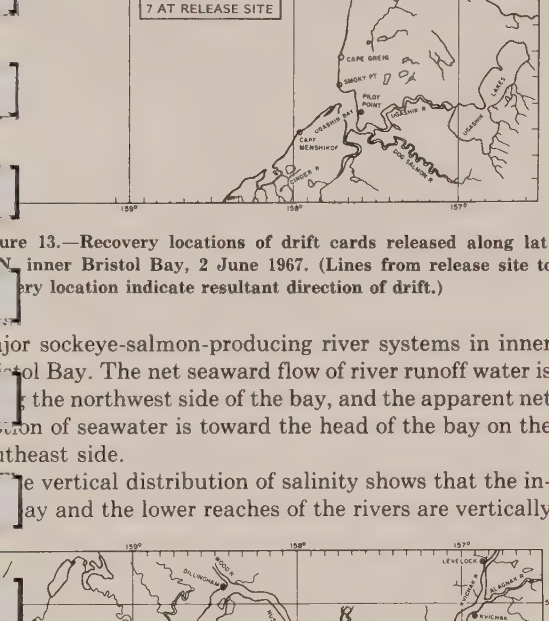

160°
159°
158°
157°
59°
58°
LEVELOCK
DILLINGHAM
WOOD R
NUSHAGAK R
KVICHAK R
ALAGNAK R
KVICHAK
KOGGIUNG
NAKNEK R
S NAKNEK
KULUKAK BAY
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
NUSHAGAK PEN.
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 21
1 AT RELEASE SITE
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

Figure 14.—Recovery locations of drift cards released off Cape Greig, inner Bristol Bay, 2 June 1967. (Lines from release site to recovery location indicate resultant direction of drift.)

jor sockeye-salmon-producing river systems in inner tol Bay. The net seaward flow of river runoff water is the northwest side of the bay, and the apparent net tion of seawater is toward the head of the bay on the theast side.

e vertical distribution of salinity shows that the in- ay and the lower reaches of the rivers are vertically homogeneous. As a result, the circulation pattern in this region does not vary with depth. The motion toward the head of the bay, as pointed out earlier, extends to and perhaps somewhat above the Middle Bluff area in Kvichak Bay.

The distribution of salinity (Figs. 3-6) and the routes of drift cards (Figs. 9-16) both indicate that waters of rivers


159°
158°
157°
59°
58°
LEVELOCK
DILLINGHAM
WOOD R
NUSHAGAK R
KVICHAK R
ALAGNAK R
KVICHAK
KOGGIUNG
NAKNEK R
S NAKNEK
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
NUSHAGAK PEN
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 4
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

ture 15.—Recovery locations of drift cards released across en- to Ugashik Bay, inner Bristol Bay, 2 June 1967. (Lines from site to recovery location indicate resultant direction of drift.)

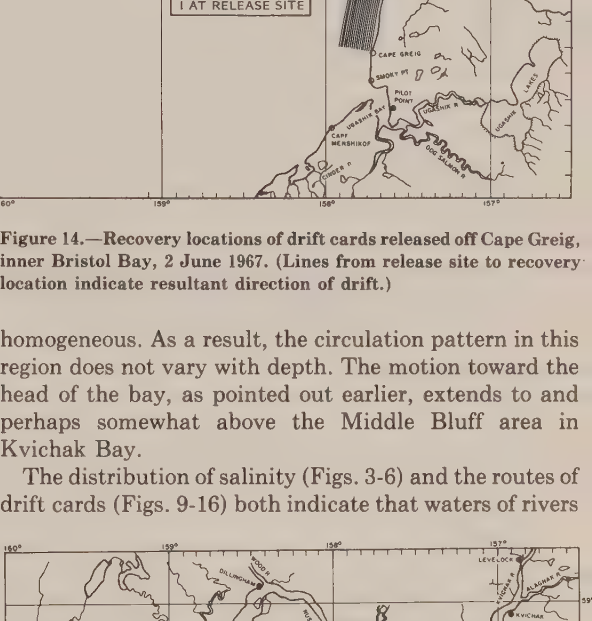

160°
159°
158°
157°
59°
58°
LEVELOCK
DILLINGHAM
WOOD R
NUSHAGAK R
KVICHAK R
ALAGNAK R
KVICHAK
KOGGIUNG
NAKNEK R
S NAKNEK
KULUKAK BAY
IGUSHIK R
CLARKS POINT
NUSHAGAK BAY
NUSHAGAK PEN.
ETOLIN PT
KVICHAK BAY
PROTECTION PT
CAPE CONSTANTINE
JOHNSTON HILL
LOW POINT
MIDDLE BLUFF
CAPE CHICHAGOF
KING SALMON R
EGEGIK BAY
EGEGIK
EGEGIK R
BECHAROF LAKE
RECOVERIES = 9
CAPE GREIG
SMOKY PT
PILOT POINT
UGASHIK BAY
UGASHIK R
UGASHIK LAKES
CAPE MENSHIKOF
DOG SALMON R
CINDER R

Figure 16.—Recovery locations of drift cards released off Cape Menshikof, inner Bristol Bay, 2 June 1967. (Lines from release site to recovery location indicate resultant direction of drift.)

draining Kvichak Bay move directly seaward along the northwest side of inner Bristol Bay past Cape Constantine. Between Egegik and Ugashik rivers and other rivers entering on the east side of the bay is a region of high-salinity water which has a net movement toward the head of Bristol Bay. Mixing and stirring will cause Egegik and Ugashik river waters entering the east side of the bay to mix with adjacent high-salinity water which has a net movement toward the head of the bay. Thus, the waters of Egegik and Ugashik rivers are carried above their mouths toward the head of the bay by the net current (Figs. 7, 8), and near Middle Bluff this water joins the flow of less saline water which is transported seaward on the northwest side of the bay.

On the southeast side toward the head of Bristol Bay and north of the mouth of Ugashik River, inshore water must become a mixture of Ugashik and Egegik river water rather than being largely Ugashik River water. Between the entrance of Egegik Bay and Middle Bluff, river water must be largely of Egegik River origin because it has a greater discharge than Ugashik River. Moreover, Ugashik River water is being diluted by lateral mixing with higher salinity offshore water during transport toward the head of the bay. In the Middle Bluff area, Egegik River water should predominate, but some Naknek River water could also be present. Kvichak River water must be well offshore in this area.

Tidal Influence

Flood tidal currents carry some Naknek, Egegik, and Ugashik river waters north or above their respective outlets into Bristol Bay, which cover tideflats exposed at low tide (Fig. 8).

Naknek River water transported north of the Naknek River mouth by the flood current mixes with Kvichak River water. This mixed water moves seaward on the succeeding ebb tide and should occur just to the west of the boundary marking the interface between water leaving Naknek and Kvichak rivers (Fig. 9). Thus, regardless of the striking separation of these waters shown by shear lines, during ebb tide there should be a gradation from Naknek to Kvichak river water from the southeast side to the northwest side of Kvichak Bay. In addition, there should also be a change from Naknek to Kvichak river water along the coast directly above Naknek River mouth during flood tide.

Egegik and Ugashik river waters transported north of the entrances to Egegik and Ugashik bays by flood tide (Fig. 8) mix with adjacent coastal waters. This mixture moves seaward on the succeeding ebb tide as part of the coastal water west of the shear line marking the separation of coastal water and waters leaving Egegik and Ugashik bays, respectively (Fig. 7). From the southeast to the northwest side of Bristol Bay in these regions, there should be a change from the coastal water of Egegik and Ugashik origin to high-salinity water, and then to low-salinity water originating from 9 of the 10 major sockeye-salmon-producing rivers entering inner Bristol Bay.

An additional effect of tidal action on the distribut
of river water is apparent in the salinity distributio
the inner bay at low and high tides (Figs. 3-6). The
tribution of certain isohalines at low and high tides
gests that a portion of the river runoff water that mo
seaward from Kvichak Bay may actually be transp
into Nushagak Bay at high tide. This river water w
be mainly of Kvichak and Naknek origin, but per
some would be of Egegik origin.

Effects of Wind

My studies were done when wind velocities
generally less than 15 knots, and the effects of prolo
strong winds on the distribution of river waters were
evaluated. Strong winds undoubtedly increase
horizontal mixing between individual river waters
between river water and seawater. Drift cards afloat
wk or more assumed a distribution similar to the cou
inferred from the salinity distribution of the area. T
cards must have encountered winds exceeding 30 k
which suggests that the circulation pattern determi
the course followed by all river waters to the northw
side of inner Bristol Bay may not have changed du
periods when winds exceeded 15 knots.

In the summer months, winds in Bristol Bay
generally from the southeast, and because the movem
of surface water is to the right of wind direction in
Northern Hemisphere (Sverdrup et al. 1942), t
southerly winds move water onshore or toward the
of Bristol Bay. Prolonged periods of strong winds may
expected then to expand or reduce the horizontal
tribution of given river waters in the inner bay. U
such conditions, one would expect it is largely Kvich
River water (which occupies the northwest side
Kvichak Bay) that is moved toward the east side o
bay and that considerable mixing between Kvichak
Naknek river waters would occur. The same situati
holds true for the other rivers entering the bay. Althou
the horizontal distribution of individual river waters
be expected to expand or be reduced under prolo
strong winds, their seaward course should remain esse
tially the same.

SUMMARY

Hydrographic studies were carried out in inner B
Bay to determine the seaward course and distributi
the waters of major sockeye-salmon-producing river s
tems draining into the bay. These studies were
ducted in conjunction with investigations of the
marine life and distribution of adult sockeye sal
while in Bristol Bay. They included: 1) determining
vertical and horizontal distributions of salinity in th
ner bay; 2) tracking and plotting the distribution
course of Naknek, Egegik, and Ugashik river waters d
ing flood and ebb with Rhodamine B dye; and 3) pl
ting the seaward course of plastic drift cards releas
several locations in inner Bristol Bay.

The results of the hydrographic studies showed that et seaward flow of the lighter and less saline river f water is along the northwest side of inner Bristol y. The net motion of high-salinity water toward the d of Bristol Bay was shown to transport with it the s of Ugashik and Egegik rivers, which enter the bay e southeast side. Near Egegik Bay to Middle Bluff se waters joined the seaward flow of Kvichak and knek river waters, which enter at the head of Bristol Waters of these four rivers, along with the large he of water from the rivers entering Nushagak Bay, eventually transported to, and moved seaward on, northwest side of Bristol Bay. Dye tracer studies ed that Naknek, Egegik, and Ugashik rivers were ar to each other in the courses followed during ebb d flood tides. Flood tide currents, along with the non- current, transported water from Egegik and hik rivers above or north of the entrance to Egegik Ugashik bays, respectively.

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RNMENT PRINTING OFFICE: 1977—797-997/23 REGION 10

NOAA Technical Report NMFS SSRF-714

Wind Stress and Wind Stress Curl Over the California Current

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August 1977

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Wind Stress and Wind Stress Curl Over the California Current

CRAIG S. NELSON[1]

ABSTRACT

Historical surface marine wind observations are summarized by 1-degree square areas and months to describe the seasonal distribution of wind stress over the California Current. Off the coasts of southern California and Baja California, an alongshore equatorward component of surface wind stress is present throughout the year. The distributions of wind stress north of Cape Mendocino are characterized by marked changes in direction and magnitude between summer and winter. The predominant wind stress maximum shifts northward coherently from off Point Conception in March to south of Cape Blanco in September, and extends approximately 500 km in the offshore direction and 1,000 km in the alongshore direction. Maximum values of surface wind stress occur during July near Cape Mendocino.

The wind stress curl is positive near the coast and negative in the region offshore. A line of zero wind stress curl parallels the coast 200 to 300 km offshore, except off central Baja California. The patterns of wind stress curl are consistent with the existence of an equatorward Sverdrup transport offshore and a poleward transport near the coast.

INTRODUCTION

patial variation of surface wind stress has long been ized as a fundamental quantity in discussions of nd-driven ocean circulation. Sverdrup's (1947) sport balance relates the vertically integrated idional mass transport in the interior ocean to the cean wind stress curl. Munk (1950) extended the to a closed basin and estimated the mass trans- s for several oceanic circulations from a knowledge of wind stress alone. Recent theoretical developments ttemped to explain the well-known westward in- cation, but have largely ignored the wind-driven lation in eastern boundary currents, such as the nia Current.

California Current flows southeastward along the coast of the United States as one branch of the large cyclonic gyre in the North Pacific Ocean. The inant surface current occurs between a cell of mospheric pressure to the west and a continental mal low situated over California. Seasonal variations he direction and strength of the surface wind are to shifts in location of the high pressure system tensification of the semipermanent thermal low. e basic flow of the California Current system may scribed in terms of the local wind stress (Reid et al. The equatorward surface current and poleward urrent are typical of eastern boundary currents oster and Reid 1963). Munk (1950) has suggested e average wind distribution off California is con- with the existence of an equatorward surface cur- offshore and a poleward current inshore. However, lack of an adequate data base has precluded a detailed analysis of the relationships among the distributions of surface wind stress, the southward flowing California Current, and the northward flowing countercurrent which appears seasonally off the coasts of California, Oregon, and Washington.

A related phenomenon in eastern boundary currents is the process of coastal upwelling. The role of upwelling in bringing nutrients into the surface layers where they are available for organic production is widely recognized. According to the simplified model (Sverdrup 1938), equatorward wind stress parallel to the coast induces flow in the surface Ekman layer of the ocean which is deflected offshore by the earth's rotation (Ekman 1905). When this occurs over an expanse of coast where horizontal surface flow cannot compensate for that driven offshore, the balance is maintained by upwelling of subsurface water. Smith (1968) suggested that wind stress, being the driving force in this mechanism, may be the most important single variable in coastal upwelling.

Previous estimates of the surface wind stress over the oceans have been based primarily on wind data taken from the U.S. Hydrographic Office Pilot Chart wind roses (Hidaka 1958; Hellerman 1967). The large-scale features evident in these distributions are consistent with the occurrence of the major cyclonic and anticyclonic circulations in the oceans. However, the coarse spatial and temporal resolution of these data (5-degree quadrilateral space average and 3-mo time average) are not adequate to describe the locally driven processes evident in the California Current system.

Wooster and Reid (1963) used Hidaka's estimates of surface wind stress to calculate the offshore Ekman transport and described the locations and seasonal timing of the major coastal upwelling regimes in terms of

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c Environmental Group, National Marine Fisheries Service, Monterey, CA 93940.

these "upwelling indices." Bakun (1973) extended the concept of the upwelling index by computing estimates of Ekman transport from routinely available analyzed surface atmospheric pressure fields. Temporal fluctuations are well described by these data. However, both the derived quantities based on Hidaka's wind stress data and Bakun's upwelling indices suffer from an inability to characterize small-scale features of the Ekman transport field, particularly near the coast. For example, where these data may indicate surface divergence on the large scale, smaller scale surface convergence might exist, with associated effects on distributions of organisms within the coastal upwelling zone.

This report provides more detailed descriptions of the surface wind stress distributions over the California Current. The study differs from previous work by calculating monthly mean values on a 1-degree square area basis. Surface marine wind observations have been utilized in the computations. Roden (1974) evaluated the surface wind stress on a 1-degree latitude-longitude grid. However, Roden's distributions were derived from monthly mean surface atmospheric pressure analyses based on a 5-degree latitude-longitude grid. Thus, any information concerning space scales smaller than 5 degrees is due to the particular interpolation scheme used to refine the data to a 1-degree grid, rather than due to observed data.

The monthly mean data described in this report adequately resolve the seasonal cycle, which is the dominant time scale for coastal upwelling (Mooers et al. 1976). The high resolution in space and time may provide the observational background for more detailed investigations of the relationships among the local wind stress distributions, the equatorward surface current offshore, the poleward surface and subsurface flow inshore, and distributions of certain species of fishes, such as the northern anchovy, *Engraulis mordax*, and the Pacific mackerel, *Scomber japonicus*.

DATA REDUCTION

The monthly mean distributions of surface wind stress presented in Appendix I are based on summaries of data contained in the National Climatic Center's file of surface marine observations (Tape Data Family-11). The total file contains approximately 40 million individual ship reports dating from the mid-19th century. Over 1 million of the reports are within the area of the California Current system.

I have compiled long-term composite monthly fields of surface wind stress on a 1-degree square area basis within the geographical area outlined in Figure 1. The data grid extends from lat. 20°N to 50°N and parallels the coastline configuration, extending 10 degrees of longitude in the offshore direction. Each 1-degree quadrilateral is centered on a whole degree of latitude and longitude. Approximately 25% of the total available reports contain positions recorded to the nearest whole degree of latitude and longitude. The grid orientation used in this study thus minimizes spatial bias which might be introd
by summarizing the data according to the Ma
square numbering system.

The historical data contain errors in po
measurement, and processing. A single pass edito
used to remove gross errors in the data, includin
licate reports (0.5%), position errors (0.1%
measurement errors (0.5%). Erroneous wind dir
and wind speeds greater than 100 m s^{-1} were rem
Reports of variable winds were treated as calms

An estimate of the surface wind stress was cal
for each wind velocity report according to the bu
mula:

$$(\tau_x, \tau_y) = \rho_a C_D \left(|\vec{W}_{10}|\, U_{10},\ |\vec{W}_{10}|\, V_{10} \right)$$

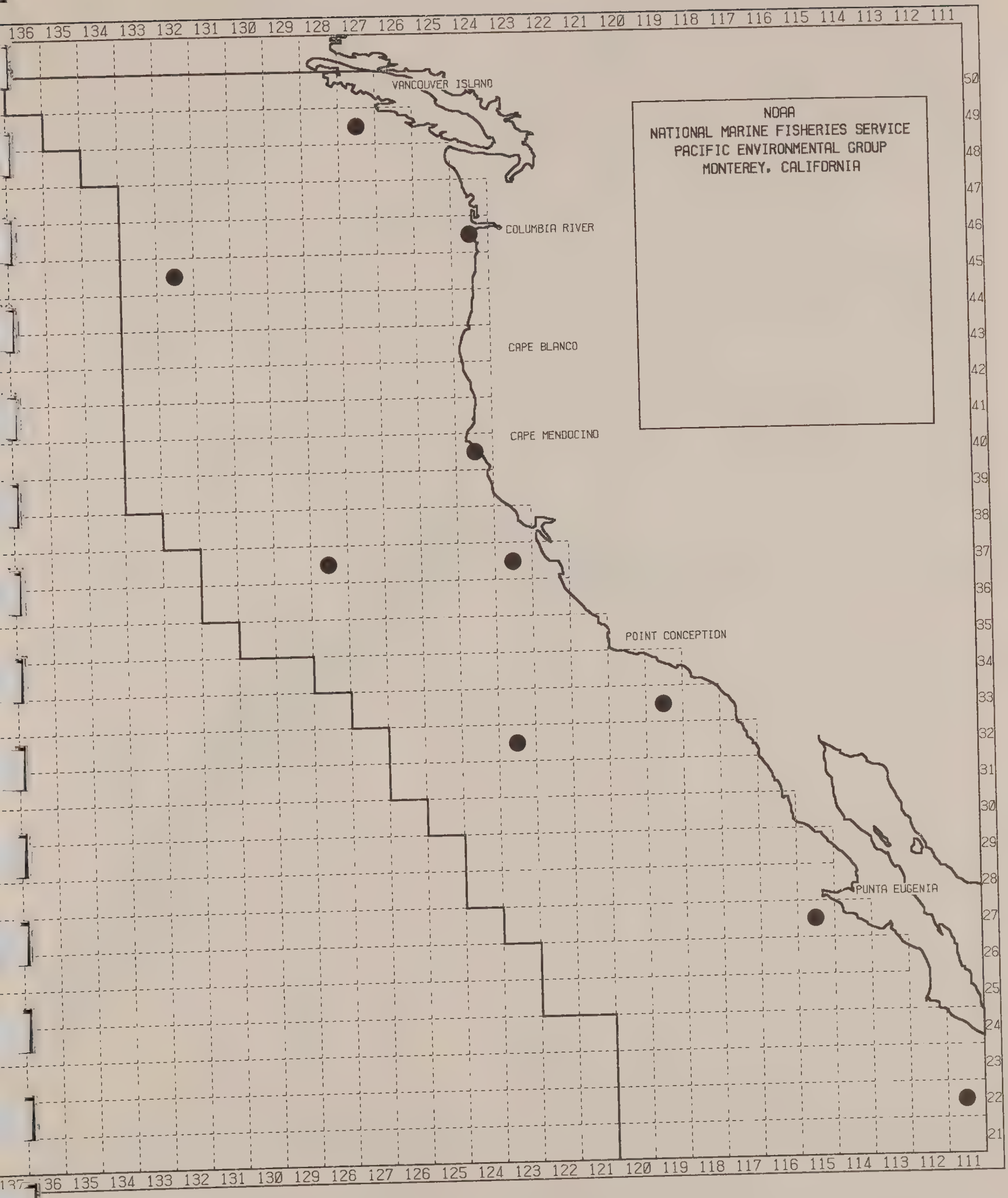
where τ_x and τ_y denote the eastward and nort
components of stress, ρ_a is the density of air wh
considered to have a constant value of 0.00122 g
$|\vec{W}_{10}|$ is the observed wind speed, and U_{10} and V
the eastward and northward components of the w
locity measured at a height of 10 m. The empiri
coefficient C_D, referred to the 10-m level, was give
stant value of 0.0013 (Kraus 1972).

The resultant long-term monthly mean win
vectors were computed as the arithmetic means
and north components of all available reports from
to 1972 within a 1-degree square area. The appro
average is defined in Equation (2):

$$(\bar{\tau}_x, \bar{\tau}_y) = \frac{1}{N} \sum_{i=1}^{N} (\tau_x, \tau_y)_i$$

where N is the total number of reports within a 1
square area and month. The values $(\tau_x, \tau_y)_i$
evaluated according to Equation (1). A mean v
each long-term month and square is therefore
from a data set which is independent of all other
and squares. The monthly fields of surface wind str
displayed in Appendix I as vector quantities (Cha
12) and as east (Charts 13 to 24) and north (Char
36) components. No attempt has been made to s
the fields, either by removing data which do not
to fit the distributions or by applying ot
smoothing procedures. The mean values were co
by computer and "bull's-eyes" in the contours
where they possibly reflect erroneous data, were
the charts as indications of the general degree of
tency in the composite distributions. The bu
may reflect either a paucity of ship observations,
treme variability associated with inadequate sam
strong winds.

The spatial distribution of observations is bia
that "ship of opportunity" reports are generall
fined to coastwise shipping lanes. Contours ind
the total numbers of observations per 1-degree
area are shown in Figure 2. The highest density of r
is found within 300 km of the coast, exceeding 40,0
servations per 1-degree square in the area south o
Conception. The number of reports per 1-degree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50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
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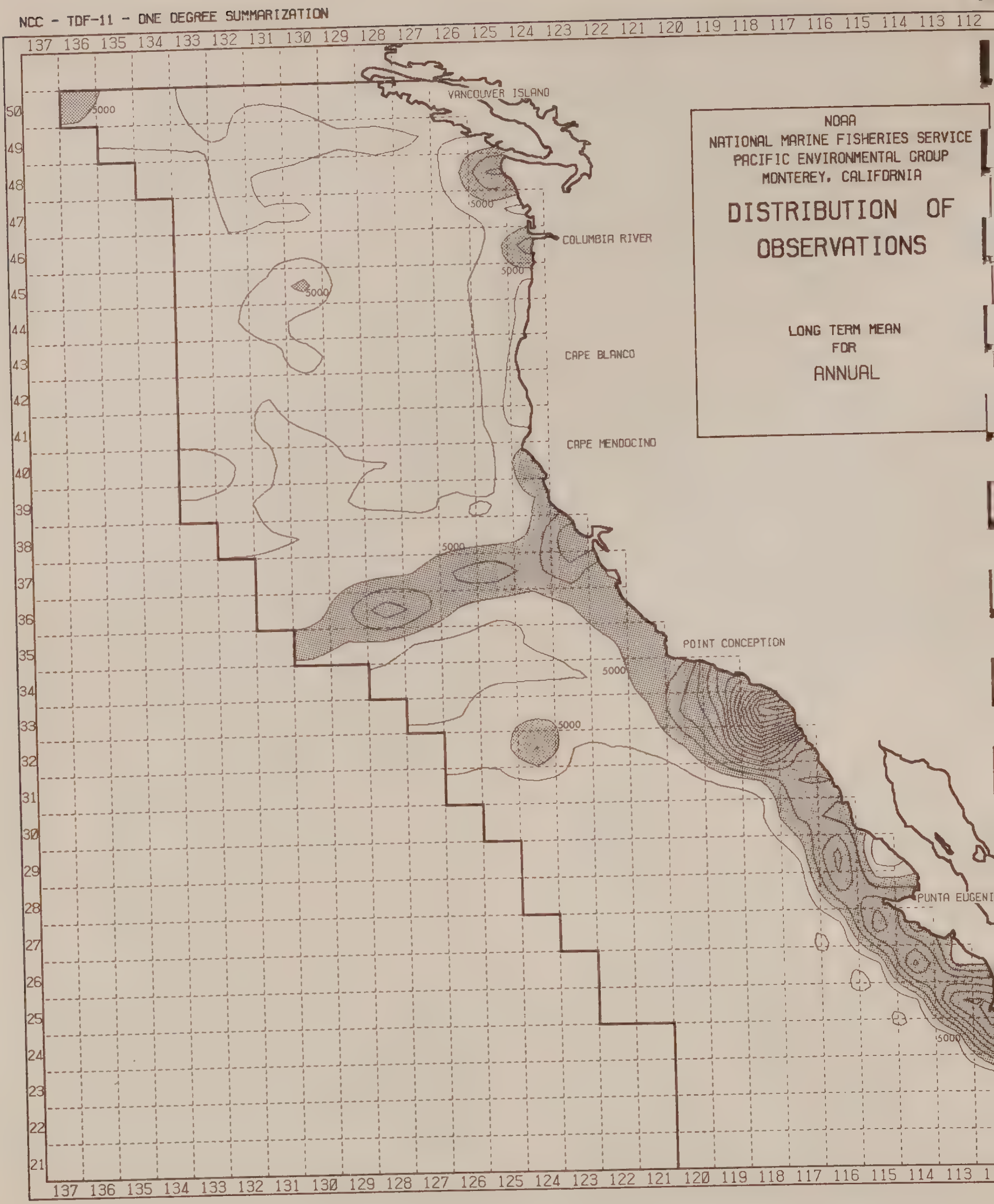
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
137 136 135 134 133 132 131 130 129 126 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

ure 1.—Chart of the west coast of the United States showing the grid of 1-degree squares used for summaries of wind observations. Large dots indicate squares for which frequency diagrams are displayed in Figures 9-12.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MONTEREY, CALIFORNIA
DISTRIBUTION OF OBSERVATIONS
LONG TERM MEAN FOR
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Figure 2.—Distribution of observations per 1-degree square. The contour interval is 2,500 observations. Values greater than 5,000 a

month varies from less than 20 (in January off Van- Island) to more than 3,800 (in May off Los s). A significant increase in the number of obser- ons is evident along the shipping route between San ncisco and Hawaii. Less than 20% of the vector means sed on fewer than 50 observations per 1-degree per month. Some temporal bias may also exist, e approximately 50% of the total reports have been n since 1945. However, the general coherence of the ng vector fields indicates that the composite wind istributions can be used to describe the dominant onal cycle in the California Current system.

historical surface marine observations used in this have been obtained primarily from ship logs, ship r reporting forms, and published ship obser- ons. The reports differ markedly in method and on of measurement, ranging from observations board 19th century vessels, to those taken aboard ern oceanographic research ships. Possible errors in measurement have been summarized by Hantel These include influences of anemometer height, heric stability, wind gusts, and duration of the rvation. Sources of error in wind estimates include wind effects observed, error in determining the true rom the observed apparent wind, and the un- ble subjectivity of the observer.

substantial portion of the historical data consists of reports based on the antiquated Beaufort wind ale (Kinsman 1968). Table 1 lists the conversion etween the Beaufort number and the equivalent d speed in knots and meters per second. These es- ates are equivalent to a wind speed measurement at a of 10 m.[2]

Table 1.—Wind speed equivalents of Beaufort force estimates in knots and meters per second.

Beaufort	Knots	ms^{-1}
0	0	0.0
1	2	0.9
2	5	2.4
3	9	4.4
4	13	6.7
5	18	9.3
6	24	12.3
7	30	15.5
8	37	18.9
9	44	22.6
10	52	26.4
11	60	30.5
12	68	34.8

d on the documentation for the National Climatic ter's data file (TDF-11),[3] a determination was made e number of wind observations estimated and those y measured by an anemometer. Approximately the reports in this study consisted of Beaufort wind force estimates. An additional 53% of the reports were estimated wind speeds which did not correspond to the Beaufort wind force scale. Less than 12% of the total reports consisted of measured quantities.

In addition to the errors introduced by the necessary calculation of true wind from the measured apparent wind, the reported directions varied in precision. Resolution varied from ±11.25° to ±5° corresponding to observations based on 16 points of a 32-point compass and a 36-point compass, respectively.

The above considerations lead to the conclusion that random observational errors may be as large as real nonseasonal fluctuations in the distributions of surface wind stress. The problem may be formalized by expressing the individual stress estimates τ_x and τ_y as the sums of monthly mean values $\bar\tau_x$ and $\bar\tau_y$, deviations from the monthly means τ'_x and τ'_y, and error terms τ^ϵ_x and τ^ϵ_y. The second and higher moment statistics will consist of the nonzero correlations between the deviations from the monthly means and the error terms. If the observational errors are greater than the real fluctuations, then the standard deviations of the monthly means will reflect observational noise rather than actual nonseasonal variability. However, provided that these errors are not systematic, the resultant first moment statistics will be the appropriate estimates of the monthly mean wind stress.

The standard error of the mean provides a more appropriate quantitative measure of the relation between the standard deviation of a set of measurements and the precision of the mean value of the data set (Young 1962). The standard errors of the means are defined by:

$$(S_{\bar\tau_x}, S_{\bar\tau_y}) = (S_{\tau_x}/\sqrt{N}, S_{\tau_y}/\sqrt{N}) \quad (3)$$

where $S_{\bar\tau_x}$ and $S_{\bar\tau_y}$ are the standard errors of the means of the eastward and northward components, respectively, S_{τ_x} and S_{τ_y} are the standard deviations, and N is the number of observations. Large values of N and small values of S_{τ_x} and S_{τ_y} correspond to mean values $\bar\tau_x$ and $\bar\tau_y$ which closely approximate the population means.

The computed standard errors of the means and numbers of observations of each 1-degree square area and long-term month are tabulated in Appendix II. Values less than 0.1 dyne cm^{-2} occur throughout a large portion of the summary area, although spatial and seasonal dependence is evident. Standard errors greater than 0.1 dyne cm^{-2} occur over large areas north of Cape Mendocino and between 500 and 1,000 km off the coast of Baja California. High values are generally associated with regions of sparse date, although inadequate sampling of intense storms may also lead to large values. Typical ratios of the standard error to the mean stress ($S_{\bar\tau_x}/\bar\tau_x$) range from 0.01 off southern California to 1.0 offshore from Cape Blanco. Near Cape Mendocino, this ratio varies between 0.02 and 0.10. Minimum values adjacent to the coast south of lat. 40°N and along the shipping lane between San Francisco and Hawaii are well correlated with the distribution of observations shown in Figure 2.

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ution 9, International Meteorological Committee, Paris, 1946.

nal Climatic Center, Tape Data Family 11, NOAA/EDS/NCC, ville, N.C.

DEPENDENCE OF STRESS ESTIMATES ON C_D

A constant drag coefficient was used to compute the surface wind stress data displayed in Appendix I. Stress calculations were made for each wind report and then averaged to form the resultant monthly mean vectors. Different results might have been obtained if the stress were calculated from monthly mean wind data, or if effects of atmospheric stability were considered. These aspects are discussed below.

Errors associated with the observational data used in this study place certain limitations on the form of the bulk exchange formula expressed in Equation (1). If measurement errors are large, there may be little value in refining the parameterization by replacing C_D by a variable drag coefficient which is a function of stability or wind speed. Even with a constant C_D, the bulk formula contains nonlinearities. Therefore, the drag coefficient must be appropriate for the particular time-averaged winds used in the calculations. That is, a drag coefficient appropriate for synoptic wind observations would not be appropriate for winds averaged over a month.

Effects of Averaging

The empirically derived transfer coefficient C_D, determined by eddy correlation and profile methods, is based on wind measurements averaged over periods of 30 to 60 min. Pond (1975) indicated that the appropriate values of $|\vec{W}_{10}|$, U_{10}, and V_{10} should be obtained over a period of a few minutes to a few hours at most. If the surface stress were calculated using winds averaged over much longer periods, a higher drag coefficient would be required. The surface stress calculated from a monthly mean surface wind field will be significantly less than the surface stress field calculated as the mean of the individual stress estimates, if the same drag coefficient is used and all other parameters are held constant.

The difference described above has been determined for the data used in this study. For each 1-degree square area and long-term month, the following ratio has been calculated:

$$(C_D)_{equ} = \overline{|\vec{\tau}|} \Big/ [\rho_a (\overline{|\vec{W}_{10}|})^2] \qquad (4)$$

where $\overline{|\vec{\tau}|}$ is the magnitude of the monthly mean surface stress, $\overline{|\vec{W}_{10}|}$ is the magnitude of the monthly mean surface wind, and $(C_D)_{equ}$ is an equivalent drag coefficient. This is the value which would be necessary to make the stress values calculated from the monthly mean wind data agree with the values calculated as the means of individual stress estimates.

Values of $(C_D)_{equ}$ for the months of June and December are shown in Figures 3 and 4. The values are significantly different from the constant value of $C_D = 0.0013$ employed in this study. In all cases, $(C_D)_{equ}$ is greater than C_D. Spatial and seasonal variability is marked. There is a tendency for higher values in the northern section of the grid the southern area. Large values of $(C_D)_{equ}$ are m dent in December than in June. Geographic seasonal variations in the quantity $(C_D)_{equ}$ agre the general geographical and seasonal fluctua meteorological conditions over the northeast Ocean. This would indicate that a large part monthly variance of the wind stress data is due to intramonth fluctuations and not due to obser errors. If a resultant surface wind stress were ca from the monthly mean wind field, these calcu imply that the wind stress estimates would be estimated, on average, by as much as 50% to 10 departures would be even larger off Oregon and W ton.

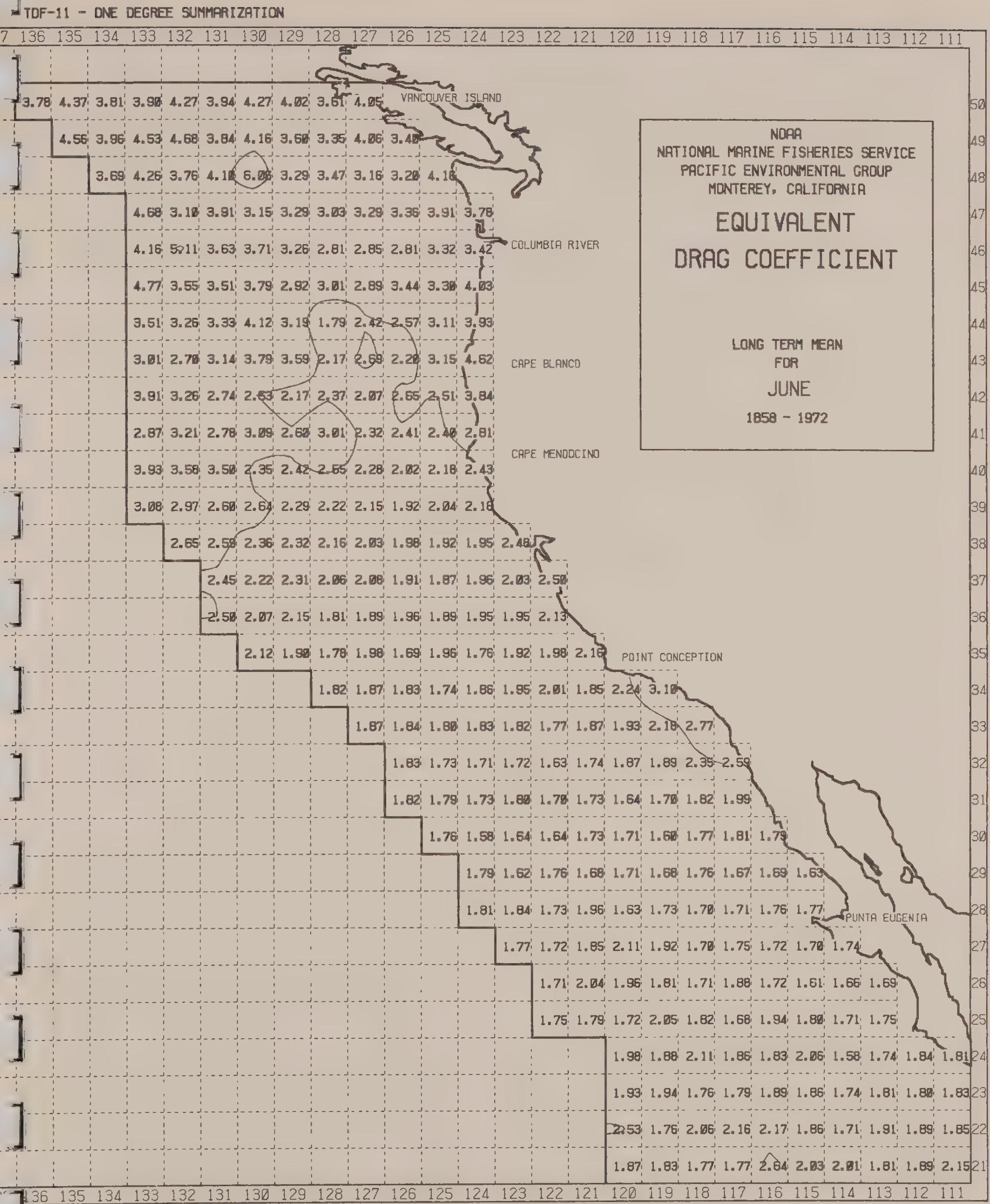
Effect of Atmospheric Stability

Investigations on the functional form of the dra ficient have alternately suggested constant valu dependence on wind speed. Wilson (1960) gave a review of the available data and adopted va $C_D = 0.0024 \pm 0.005$ for strong winds and $C_D =$ $\pm\ 0.0008$ for light winds. Smith (1970) propose stant value of $C_D = (1.35 \pm 0.34) \times 10^{-3}$. W adopted the form $C_D = (0.5 \times \overline{U}_{10}{}^{1/2}) \times 10$ sidering the large scatter in the open ocean minations of C_D, the lack of conclusive data speeds greater than 15 ms^{-1}, and the lack of ag among individual observers, a constant value neutral drag coefficient was used in this study.

Recent investigations by Davidson (1974) a man and Miyake (1973) have demonstrated the dence of the drag coefficient on atmospheric stabil the spectral shape of the ocean wave field. A g accepted formulation of the dependence of C_D properties does not seem well enough establishe incorporated in the calculations of surface wind based on historical ship observations. However, e atmospheric stability on the momentum excha be significant in regions where seasonal up typically produces a stable boundary layer.

The specific effects of atmospheric stability o change of momentum have not been complete mined and are still under investigation. Howeve given wind speed, the effect of stable (u stratification is to decrease (increase) the magn the momentum exchange (surface wind stress) a atmosphere-ocean interface.

In order to investigate the effects of atm stability, the monthly mean fields of surface wi were recomputed, replacing the constant value Equation (1) by a coefficient varying with atmo stability. Deardorff (1968) defined the bulk Ri number as an appropriate dimensionless measu mospheric stability. Deardorff's method was ado parameterize the dependence of the drag coeffi stability, while neutral stability was assumed absolute value of the air-sea temperature differe


TDF-11 - ONE DEGREE SUMMARIZATION
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FOR
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1858 - 1972
VANCOUVER ISLAND
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CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
7 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
3.78 4.37 3.81 3.90 4.27 3.94 4.27 4.02 3.61 4.05
4.56 3.96 4.53 4.68 3.84 4.16 3.60 3.35 4.06 3.40
3.69 4.26 3.76 4.10 6.08 3.29 3.47 3.16 3.20 4.18
4.68 3.10 3.91 3.15 3.29 3.03 3.29 3.36 3.91 3.78
4.16 5.11 3.63 3.71 3.26 2.81 2.85 2.81 3.32 3.42
4.77 3.55 3.51 3.79 2.92 3.01 2.89 3.44 3.30 4.03
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3.01 2.70 3.14 3.79 3.59 2.17 2.69 2.20 3.15 4.62
3.91 3.26 2.74 2.63 2.17 2.37 2.07 2.65 2.51 3.84
2.87 3.21 2.78 3.09 2.60 3.01 2.32 2.41 2.40 2.81
3.93 3.58 3.50 2.35 2.42 2.55 2.28 2.02 2.18 2.43
3.08 2.97 2.60 2.64 2.29 2.22 2.15 1.92 2.04 2.18
2.65 2.59 2.36 2.32 2.16 2.03 1.98 1.92 1.95 2.48
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1.82 1.79 1.73 1.80 1.70 1.73 1.64 1.70 1.82 1.99
1.76 1.58 1.64 1.64 1.73 1.71 1.60 1.77 1.81 1.79
1.79 1.62 1.76 1.68 1.71 1.68 1.76 1.67 1.69 1.63
1.81 1.84 1.73 1.96 1.63 1.73 1.70 1.71 1.76 1.77
1.77 1.72 1.85 2.11 1.92 1.70 1.75 1.72 1.70 1.74
1.71 2.04 1.96 1.81 1.71 1.88 1.72 1.61 1.66 1.69
1.75 1.79 1.72 2.05 1.82 1.68 1.94 1.80 1.71 1.75
1.98 1.88 2.11 1.85 1.83 2.06 1.58 1.74 1.84 1.81
1.93 1.94 1.76 1.79 1.89 1.86 1.74 1.81 1.80 1.83
2.53 1.76 2.06 2.16 2.17 1.86 1.71 1.91 1.89 1.85
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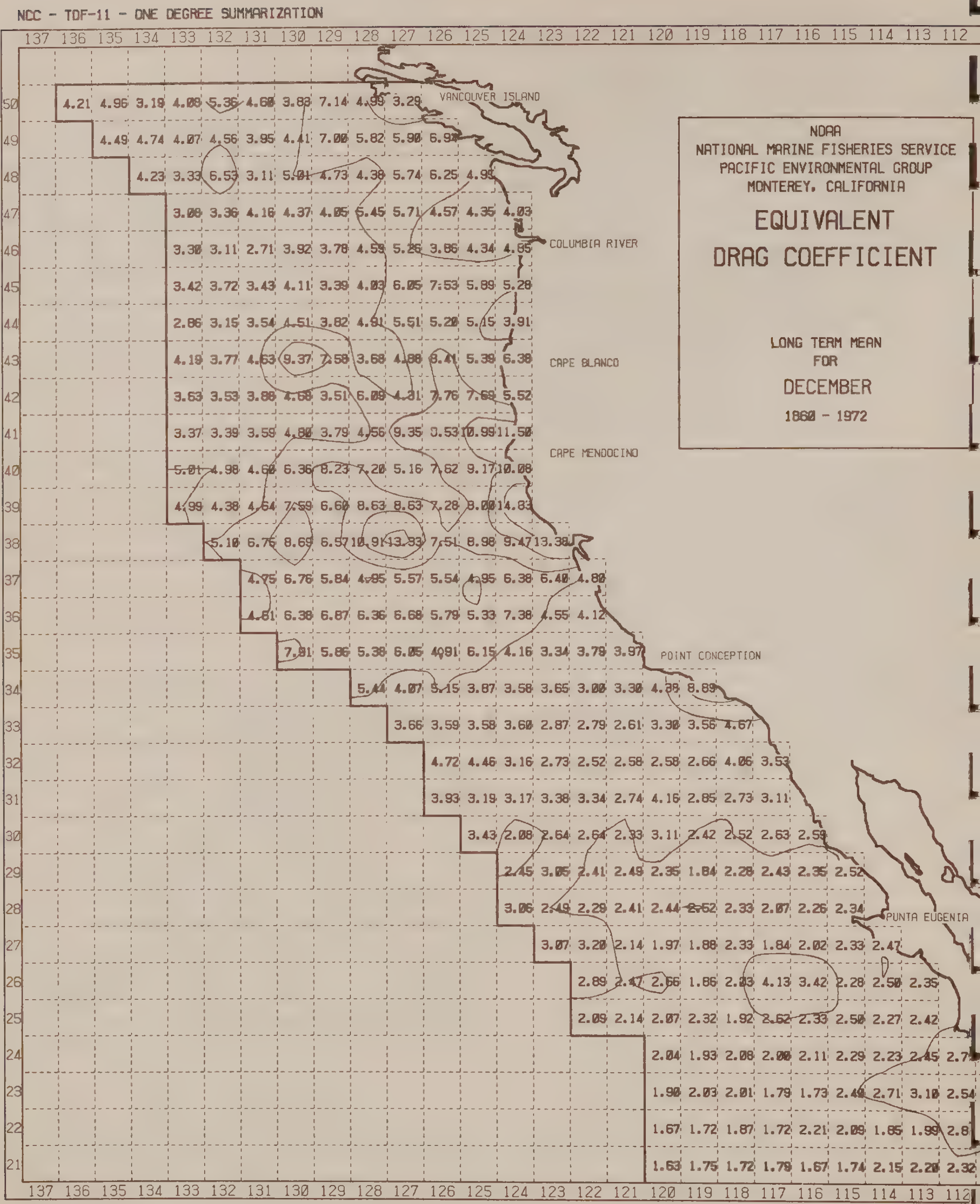
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

e 3.—Equivalent neutral drag coefficient for June. The plotted value is the drag coefficient ($\times 10^3$) appropriate for wind observations averaged over a month. The contour interval is 2.5.


NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EQUIVALENT
DRAG COEFFICIENT
LONG TERM MEAN
FOR
DECEMBER
1860 - 1972
50 4.21 4.96 3.19 4.08 5.36 4.60 3.83 7.14 4.99 3.29
49 4.49 4.74 4.07 4.56 3.95 4.41 7.00 5.82 5.90 6.97
48 4.23 3.33 6.53 3.11 5.01 4.73 4.38 5.74 6.25 4.93
47 3.08 3.36 4.16 4.37 4.05 5.45 5.71 4.57 4.35 4.03
46 3.30 3.11 2.71 3.92 3.78 4.59 5.25 3.86 4.34 4.85
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43 4.19 3.77 4.63 9.37 7.58 3.68 4.88 8.41 5.39 6.38
42 3.63 3.53 3.88 4.68 3.51 6.09 4.31 7.76 7.68 5.52
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37 4.75 6.76 5.84 4.85 5.57 5.54 4.95 6.38 6.40 4.80
36 4.61 6.38 6.87 6.36 6.68 5.79 5.33 7.38 4.55 4.12
35 7.81 5.86 5.38 6.05 4.91 6.15 4.16 3.34 3.79 3.97
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25 2.09 2.14 2.07 2.32 1.92 2.62 2.33 2.50 2.27 2.42
24 2.04 1.93 2.08 2.00 2.11 2.29 2.23 2.45 2.7
23 1.90 2.03 2.01 1.79 1.73 2.40 2.71 3.10 2.54
22 1.67 1.72 1.87 1.72 2.21 2.09 1.85 1.99 2.8
21 1.63 1.75 1.72 1.79 1.67 1.74 2.15 2.20 2.32
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112

Figure 4.—Equivalent neutral drag coefficient for December. The plotted value is the drag coefficient (× 10^3) appropriate for wind obser averaged over a month. The contour interval is 2.5.

than 1°C. Details of the calculations will be reported where.

effect of atmospheric stability was computed as a age increase (decrease) in the magnitude of the thly mean surface wind stress above (below) the ap- te neutral values. The following ratio was cal- :

$$R = \left(\frac{|\vec{\tau}|_{var}}{|\vec{\tau}|_{neu}} - 1 \right) \times 100 \qquad 5$$

re $|\vec{\tau}|_{var}$ is the magnitude of the monthly mean sur- nd stress calculated using a drag coefficient which with stability, and $|\vec{\tau}|_{neu}$ is the magnitude of the y mean surface wind stress computed with a con- t (neutral) coefficient. A value of $R = 0.0$ cor- ds to neutrally stable conditions.

ratio defined by Equation (5) is displayed in res 5 and 6 for the months of June and December, ectively. The average percentage difference is n 2 and 5%. Values greater than 10% are rare. In ber, the values are positive, indicating unstable itions. Negative values occur in June. These are ed to the stable stratification induced by positive temperature differences within the coastal up- zone. The effects of atmospheric stability deter- ed in this study are less than the values of 6 to 15% d by Husby and Seckel (1975) for Ocean Weather "Victor," but consistent with the values of less % reported by Dorman et al. (1974) for Ocean ther Station "November."

WIND STRESS DISTRIBUTIONS

e long-term composite monthly mean fields of sur- nd stress are displayed in Appendix I as resultant (Charts 1 to 12), east components (Charts 13 to and north components (Charts 25 to 36). These data ate two characteristic features. The mean stress o be directed equatorward along the coast from endocino to Baja California throughout the year. he coasts of Oregon and Washington, the wind stress its marked seasonal variability in both magnitude ection.

distributions of surface wind stress off Baja ornia have been previously discussed by Bakun and (1975).[4] They concluded that most of the seasonal ity is in magnitude rather than direction. The urface wind stress tends to have an alongshore, torward component during all months, implying ns generally favorable for coastal upwelling out the year. This is contrasted with the situa- to the north. Off the coasts of Oregon and Washing- patterns of surface wind stress change seasonally. ecember to February, the stress impinges on the coast at Cape Blanco, forming the southern boundary of the low pressure system which develops in the Gulf of Alaska during the winter. From May through September, the surface wind stress veers toward the south. The components are directed onshore and equatorward. The months of March-April and October-November appear as transition periods. The surface wind stress is directed primarily onshore off Washington and Oregon during these months.

The most evident feature in these distributions is the position and extent of the predominant wind stress maximum. For purposes of discussion, this maximum is defined by the 1.0 dyne cm^{-2} contour and is highlighted by light shading in Charts 1 to 12. Large values of stress occurring between lat. 45°N and 50°N during winter are probably associated with either high winds or sparse data, and will be ignored in this discussion.

The maximum is first evident in March, south of Point Conception. During succeeding months, the maximum strengthens, increases in size, and shifts northward. In April, values exceeding 1.0 dyne cm^{-2} cover an area from Point Conception to San Francisco. Winds off Oregon have veered, suggesting an alongshore component and implying conditions generally favorable for coastal upwelling. The pattern of surface wind stress is repeated in May. The northern boundary of the central maximum reaches the coast south of Cape Blanco.

The mean wind stress reaches maximum intensity during June and July off Cape Mendocino, where characteristic values exceed 1.5 dynes cm^{-2}. The large-scale maximum extends approximately 500 km in the offshore direction and 1,000 km in the longshore direction. A more intense coastal maximum ($|\vec{\tau}| \geq 1.5$ dynes cm^{-2}) is coherent over an area approximately one-fifth this size. Maximum values of mean surface wind stress typically occur 200 to 300 km off the coast, rather than adjacent to the coast. This feature was previously observed by Munk (1950) and Reid et al. (1958). Mean distributions for August and September suggest relaxing conditions; the maximum is reduced in extent and intensity. These months still exhibit a degree of equatorward stress along the coasts of Oregon and Washington, but in October, the direction backs to the north. The poleward components correspond to onshore Ekman transport and subsequent downwelling at the coast. The distributions for November, December, January, and February indicate characteristic winter conditions. Mean values are typically less than 0.5 dyne cm^{-2}. High winds associated with intense storm activity in the North Pacific Ocean result in regions of mean surface wind stress exceeding 1.0 dyne cm^{-2} off the coasts of Oregon and Washington.

Seasonality of the surface wind stress and its association with coastal upwelling are easily observed along the northern section of the grid. Large changes in mean direction are apparent. Maximum magnitudes occur during the winter. Winds favorable for coastal upwelling occur from April to September. During the remaining months, the direction of the mean surface wind stress corresponds to downwelling at the coast.

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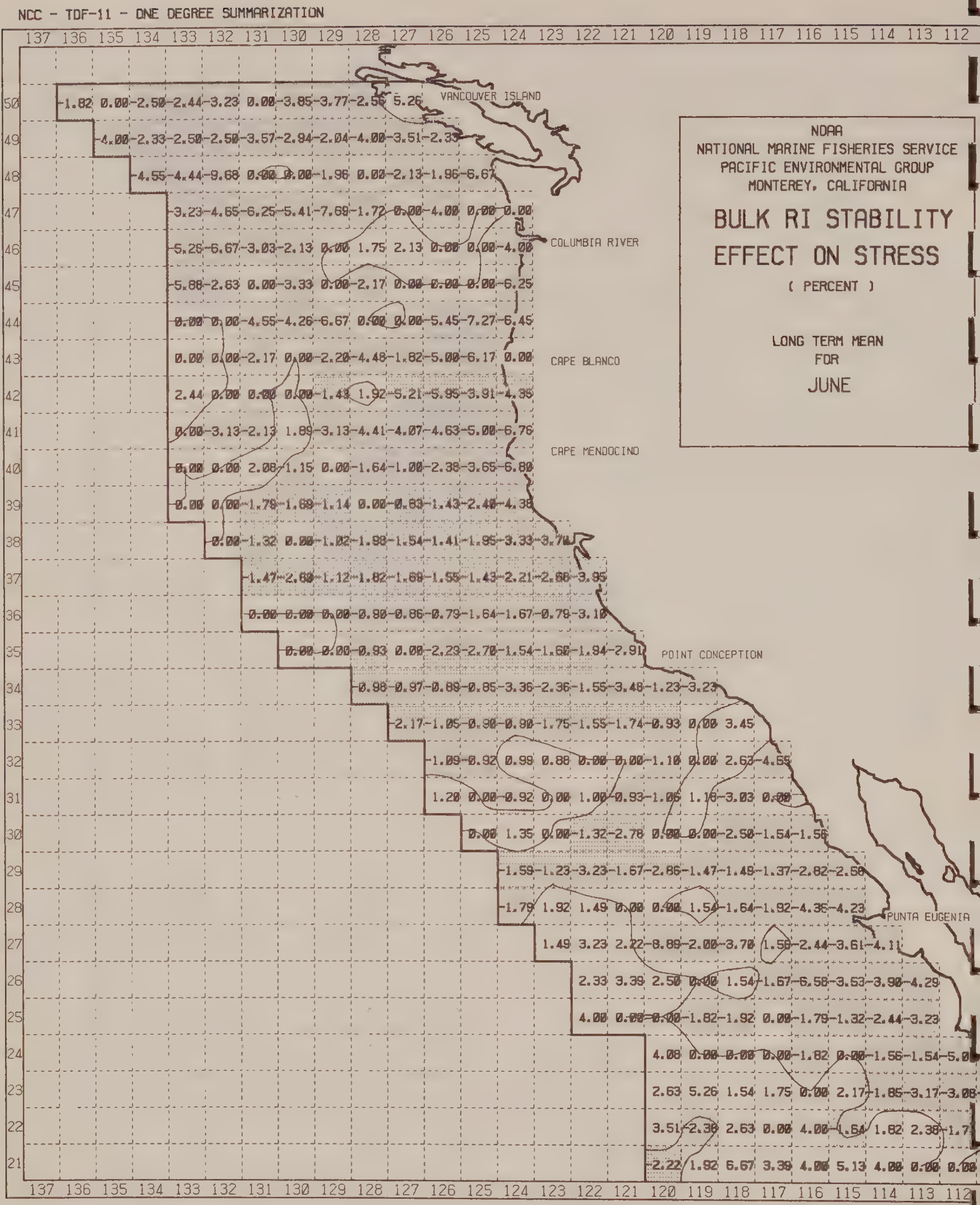
un, A. and C. S. Nelson, 1975. Climatology of upwelling-related off Baja California. Unpubl. manuscr., 41 p. On file at Pacific ental Group, National Marine Fisheries Service, NOAA, Mon- 93940.



NCC - TDF-11 - ONE DEGREE SUMMARIZATION
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VANCOUVER ISLAND
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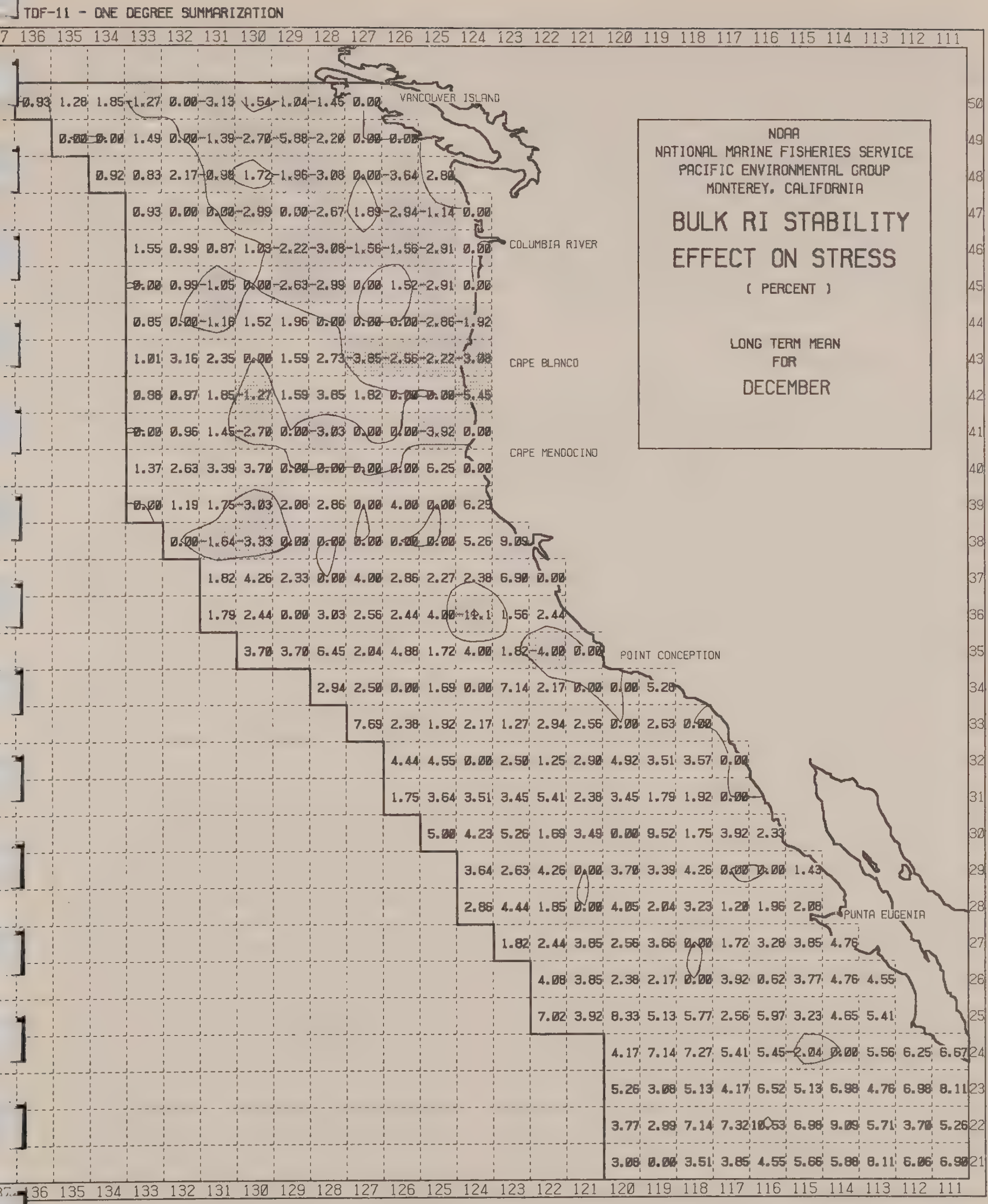
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
BULK RI STABILITY
EFFECT ON STRESS
(PERCENT)
LONG TERM MEAN
FOR
JUNE
-1.82 0.00 -2.50 -2.44 -3.23 0.00 -3.85 -3.77 -2.56 5.26
-4.00 -2.33 -2.50 -2.50 -3.57 -2.94 -2.04 -4.00 -3.51 -2.33
-4.55 -4.44 -9.68 0.00 0.00 -1.96 0.00 -2.13 -1.96 -6.67
-3.23 -4.65 -6.25 -5.41 -7.69 -1.72 0.00 -4.00 0.00 0.00
-5.26 -6.67 -3.03 -2.13 0.00 1.75 2.13 0.00 0.00 -4.00
-5.88 -2.63 0.00 -3.33 0.00 -2.17 0.00 0.00 0.00 -6.25
0.00 0.00 -4.55 -4.26 -6.67 0.00 0.00 -5.45 -7.27 -6.45
0.00 0.00 -2.17 0.00 -2.20 -4.48 -1.82 -5.00 -6.17 0.00
2.44 0.00 0.00 0.00 -1.43 1.92 -5.21 -5.95 -3.91 -4.35
0.00 -3.13 -2.13 1.89 -3.13 -4.41 -4.07 -4.63 -5.00 -6.76
0.00 0.00 2.08 1.15 0.00 -1.64 -1.00 -2.38 -3.65 -6.80
0.00 0.00 -1.79 -1.69 -1.14 0.00 -0.83 -1.43 -2.40 -4.38
0.00 -1.32 0.00 -1.02 -1.98 -1.54 -1.41 -1.95 -3.33 -3.70
-1.47 -2.60 -1.12 -1.82 -1.69 -1.55 -1.43 -2.21 -2.68 -3.95
0.00 0.00 0.00 -0.90 -0.86 -0.79 -1.64 -1.67 -0.79 -3.10
0.00 0.00 -0.93 0.00 -2.23 -2.70 -1.54 -1.60 -1.94 -2.91
-0.96 -0.97 -0.89 -0.85 -3.36 -2.36 -1.55 -3.48 -1.23 -3.23
-2.17 -1.05 -0.90 -0.80 -1.75 -1.55 -1.74 -0.93 0.00 3.45
-1.09 -0.92 0.99 0.88 0.00 0.00 -1.10 0.00 2.63 -4.55
1.20 0.00 -0.92 0.00 1.00 -0.93 -1.06 1.10 -3.03 0.00
0.00 1.35 0.00 -1.32 -2.78 0.00 0.00 -2.50 -1.54 -1.56
-1.59 -1.23 -3.23 -1.67 -2.86 -1.47 -1.49 -1.37 -2.82 -2.58
-1.79 1.92 1.49 0.00 0.00 1.54 -1.64 -1.92 -4.35 -4.23
1.49 3.23 2.22 -8.89 -2.00 -3.70 1.56 -2.44 -3.61 -4.11
2.33 3.39 2.50 0.00 1.54 -1.67 -6.58 -3.53 -3.90 -4.29
4.00 0.00 0.00 -1.82 -1.92 0.00 -1.79 -1.32 -2.44 -3.23
4.08 0.00 0.00 0.00 -1.82 0.00 -1.56 -1.54 -5.0
2.63 5.26 1.54 1.75 0.00 2.17 -1.85 -3.17 -3.08
3.51 -2.38 2.63 0.00 4.00 -1.54 1.82 2.38 -1.7
-2.22 1.92 6.67 3.39 4.00 5.13 4.00 0.00 0.00

Figure 5.—The effect of atmospheric stability on surface wind stress for June. Plotted values are the percentage increase (decrease) in
face wind stress above (below) neutrally stable conditions. The contour interval is 10.0. Positive values correspond to unstable condition
tive values are shaded.


TDF-11 - ONE DEGREE SUMMARIZATION
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MONTEREY, CALIFORNIA
BULK RI STABILITY
EFFECT ON STRESS
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136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
0.93 1.28 1.85-1.27 0.00-3.13 1.54-1.04-1.45 0.00
0.00 0.00 1.49 0.00-1.39-2.70-5.88-2.20 0.00 0.00
0.92 0.83 2.17-0.98 1.72-1.96-3.08 0.00-3.64 2.80
0.93 0.00 0.00-2.89 0.00-2.67 1.89-2.94-1.14 0.00
1.55 0.99 0.87 1.03-2.22-3.08-1.56-1.56-2.91 0.00
0.00 0.99-1.05 0.00-2.63-2.99 0.00 1.52-2.91 0.00
0.85 0.00-1.16 1.52 1.96 0.00 0.00 0.00-2.86-1.92
1.01 3.16 2.35 0.00 1.59 2.73-3.85-2.56-2.22-3.08
0.88 0.97 1.85-1.27 1.59 3.85 1.82 0.00 0.00-5.45
0.00 0.96 1.45-2.70 0.00-3.03 0.00 0.00-3.92 0.00
1.37 2.63 3.39 3.70 0.00 0.00 0.00 0.00 6.25 0.00
0.00 1.19 1.75-3.03 2.08 2.86 0.00 4.00 0.00 6.25
0.00-1.64-3.33 0.00 0.00 0.00 0.00 0.00 5.26 9.09
1.82 4.26 2.33 0.00 4.00 2.86 2.27 2.38 6.90 0.00
1.79 2.44 0.00 3.03 2.56 2.44 4.00-14.1 1.56 2.44
3.70 3.70 6.45 2.04 4.88 1.72 4.00 1.82-4.00 0.00
2.94 2.50 0.00 1.69 0.00 7.14 2.17 0.00 0.00 5.28
7.69 2.38 1.92 2.17 1.27 2.94 2.56 0.00 2.63 0.00
4.44 4.55 0.00 2.50 1.25 2.90 4.92 3.51 3.57 0.00
1.75 3.64 3.51 3.45 5.41 2.38 3.45 1.79 1.92 0.00
5.00 4.23 5.26 1.69 3.49 0.00 9.52 1.75 3.92 2.33
3.64 2.63 4.26 0.00 3.70 3.39 4.26 0.00 0.00 1.43
2.86 4.44 1.85 0.00 4.05 2.04 3.23 1.20 1.96 2.08
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4.17 7.14 7.27 5.41 5.45-2.04 0.00 5.56 6.25 6.67
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3.77 2.99 7.14 7.32 10.53 6.98 9.09 5.71 3.70 5.26
3.08 0.00 3.51 3.85 4.55 5.66 5.88 8.11 6.06 6.90

e 6.—The effect of atmospheric stability on surface wind stress for December. Plotted values are the percentage increase (decrease) in the e ind stress above (below) neutrally stable conditions. The contour interval is 10.0. Positive values correspond to unstable conditions. values are shaded.

The coast along southern California and Baja California is characterized by winds favorable for upwelling throughout the year. Peak values of surface wind stress occur in April and May. Values exceeding 0.5 dyne cm^{-2} are evident from February to July. A local maximum immediately north of Punta Eugenia is easily observed in May. This feature is consistent throughout the year. A region of local wind stress minima is indicated along the coast south of Point Conception. This feature corresponds in location with the semipermanent cyclonic eddy which dominates the ocean surface circulation in the Southern California Bight (Reid et al. 1958).

Spatial and Temporal Variability

Spatial and seasonal variability of the monthly distributions will be described in terms of standard errors of the means (Equation (3)), constancy of the wind stress, and frequency diagrams for selected 1-degree square areas and months. In general, these data indicate greater variability in magnitude and direction in the region north of Cape Mendocino than in the area to the south. Summer distributions are characterized by well-defined mean directions and magnitudes. Broad-banded frequency histograms are typical of winter months.

The degree of variability in direction and magnitude of the surface wind stress is reflected in the spatial distributions of the standard errors of the means. In regions outside of the primary shipping lanes (see Fig. 2), monthly mean distributions are based on approximately the same number of observations per 1-degree square area. If one assumes that there are no systematic sampling errors in these regions, then the magnitudes of the computed standard errors of the means should be a function of the wind stress variability. Accordingly, standard errors to the north of Cape Mendocino are larger by a factor of 2 to 3 (Appendix II) than those to the south of Cape Mendocino. Thus, the data imply a greater degree of variation in the direction and magnitude of the surface wind stress off Oregon and Washington than off California.

A contrast between winter and summer conditions is also evident. South of Cape Mendocino, magnitudes of the standard errors of the means remain nearly constant throughout the year. Off Oregon and Washington, the computed values decrease to a minimum during the summer, and increase to a maximum during the winter. Typical values range from 0.10 dyne cm^{-2} in June to 0.30 dyne cm^{-2} in December.

Similar features of the large-scale temporal and spatial variations are evident in monthly distributions of constancy of the wind stress as defined by the ratio of the magnitude of the average stress to the average magnitude of the stress. Figures 7 and 8 show the patterns for June and December. During December, values greater than 0.5 occur south of Point Conception. To the north, wind stress constancy decreases to relatively small values, implying a high degree of directional variability. An increase in directional constancy is indicated during
June. Values greater than 0.50 extend from Baja C
nia to Vancouver Island. Values less than 0.50 oc
in the northwest section of the grid. South of Ca
docino, the ratios approach a value of 1.0, implyi
little variation in wind stress direction.

The patterns of wind stress constancy indic
sible error in estimates of the total mechnical
transfer at the air-sea interface. In the region off C
nia, the magnitude of the mean vector wind
appears to be a good estimator of the total stres
on the sea surface. However, in the northern re
the data grid, these data show that the magnitude
mean vector wind stress underestimates the tota
acting on the sea surface. This has importa
plications for mixed-layer modelling, in which th
of turbulent energy depends on the total stress act
the sea surface (Denman 1973), the direction of
face stress, and the rate at which the stress is ap
the sea surface (Niiler 1975).

The large-scale spatial and temporal variations
face wind stress distributions are finally descr
terms of selected frequency diagrams. Data for
squares indicated in Figure 1 are displayed in Fig
to 12. Figures 9 and 10 show data for June and
ber taken from the five squares indicated in th
Similar data at five different locations are prese
July and January in Figures 11 and 12.[5]

Available wind stress data have been classed b
tion and magnitude for each 1-degree square a
month. Relative frequencies have been determine
direction bands and for 11 magnitude bands. A ca
for calm winds also includes variable winds. Th
tion bands are 22.5° wide and the magnitude ba
respond to equivalent wind speed intervals of 2.0

The relative frequency surfaces shown in these
display contours of percentage of total reports
within a given direction and magnitude band. T
and 7.5% contours are indicated by a solid line.
line contours indicate relative frequencies of 5.0
10.0%. The mean vector magnitude and directio
dicated by an arrow. Note that directions are
with the oceanographic convention (i.e., the di
toward which the wind blows).

The histograms shown to the right of each fr
surface display relative frequencies for magnitud
top, and direction at the bottom. Relative per
labelled along the ordinate. Midpoints of the ma
and direction class intervals are labelled on the a

The contrast between winter and summe
tributions in the southern section of the grid appea
change in the character of the frequency surfaces
10). In general, the number of contours indica
June is greater than the number of contours appea
December. Evidently, the wind stress is relativ
stant in magnitude and direction during the

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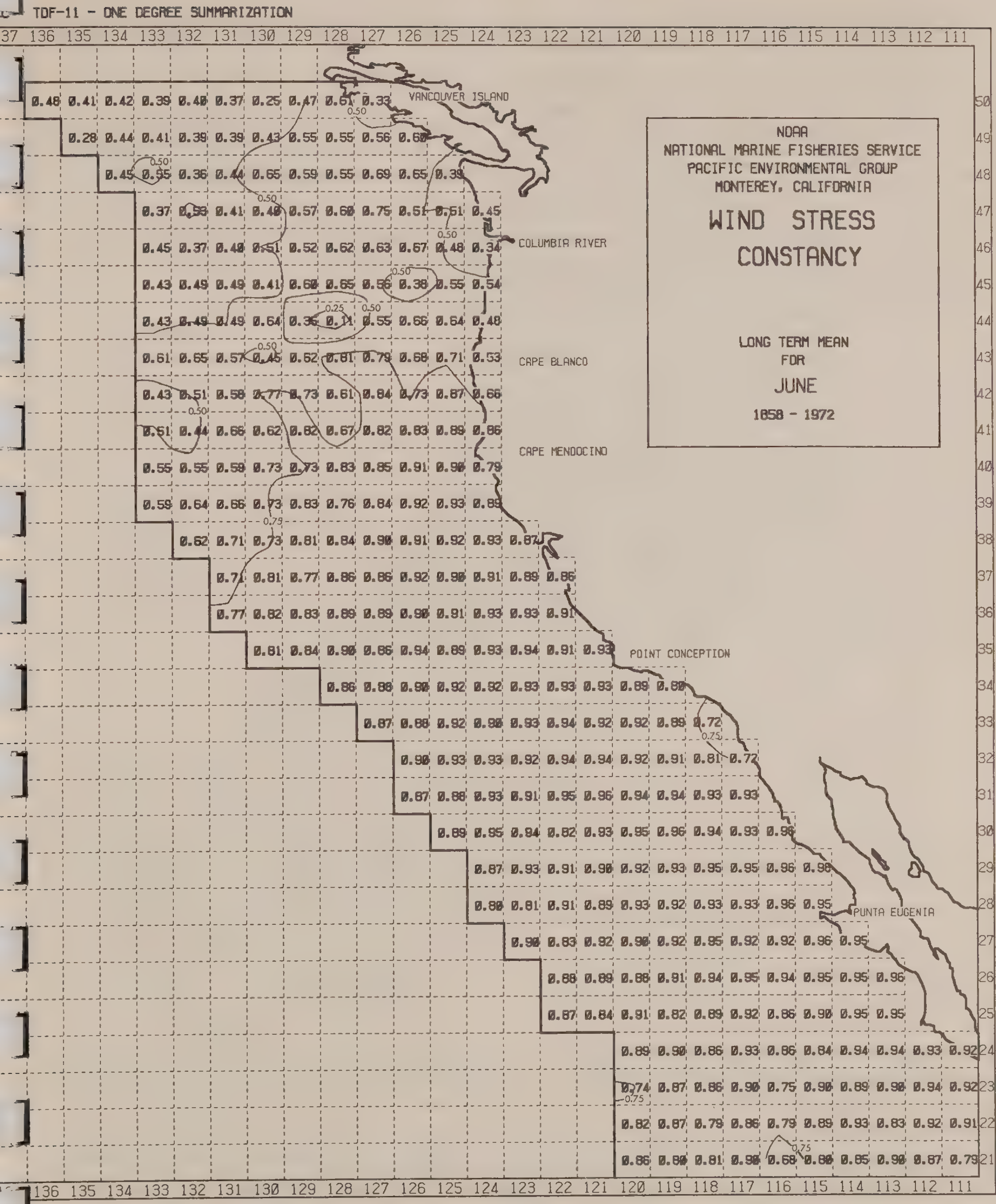
[5] Wind roses for all 1-degree squares within the area north of
may be found in *Climatic study of the near coastal zone; We
the United States*, published by the Director, Naval Oceanog
Meteorology, June 1976, 133 p.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MONTEREY, CALIFORNIA
WIND STRESS
CONSTANCY
LONG TERM MEAN
FOR
JUNE
1858 - 1972
0.25
0.50
0.75
0.48 0.41 0.42 0.39 0.40 0.37 0.25 0.47 0.61 0.33
0.28 0.44 0.41 0.39 0.39 0.43 0.55 0.55 0.56 0.60
0.45 0.55 0.36 0.44 0.65 0.59 0.55 0.69 0.65 0.39
0.37 0.53 0.41 0.40 0.57 0.60 0.75 0.51 0.51 0.45
0.45 0.37 0.40 0.51 0.52 0.62 0.63 0.67 0.48 0.34
0.43 0.49 0.49 0.41 0.60 0.65 0.56 0.38 0.55 0.54
0.43 0.49 0.49 0.64 0.36 0.11 0.55 0.66 0.64 0.48
0.61 0.65 0.57 0.45 0.52 0.81 0.79 0.68 0.71 0.53
0.43 0.51 0.58 0.77 0.73 0.61 0.84 0.73 0.87 0.66
0.51 0.44 0.66 0.62 0.82 0.67 0.82 0.83 0.89 0.86
0.55 0.55 0.59 0.73 0.73 0.83 0.85 0.91 0.90 0.79
0.59 0.64 0.66 0.73 0.83 0.76 0.84 0.92 0.93 0.89
0.62 0.71 0.73 0.81 0.84 0.90 0.91 0.92 0.93 0.87
0.71 0.81 0.77 0.86 0.86 0.92 0.90 0.91 0.89 0.86
0.77 0.82 0.83 0.89 0.89 0.90 0.91 0.93 0.93 0.91
0.81 0.84 0.90 0.86 0.94 0.89 0.93 0.94 0.91 0.93
0.86 0.88 0.90 0.92 0.82 0.93 0.93 0.93 0.89 0.80
0.87 0.88 0.92 0.90 0.93 0.94 0.92 0.92 0.89 0.72
0.90 0.93 0.93 0.92 0.94 0.94 0.92 0.91 0.81 0.72
0.87 0.88 0.93 0.91 0.95 0.96 0.94 0.94 0.93 0.93
0.89 0.95 0.94 0.82 0.93 0.95 0.96 0.94 0.93 0.96
0.87 0.93 0.91 0.90 0.92 0.93 0.95 0.95 0.96 0.98
0.80 0.81 0.91 0.89 0.93 0.92 0.93 0.93 0.96 0.95
0.90 0.83 0.92 0.90 0.92 0.95 0.92 0.92 0.96 0.95
0.88 0.89 0.88 0.91 0.94 0.95 0.94 0.95 0.95 0.96
0.87 0.84 0.91 0.82 0.89 0.92 0.86 0.90 0.95 0.95
0.89 0.90 0.86 0.93 0.86 0.84 0.94 0.94 0.93 0.92
0.74 0.87 0.86 0.90 0.75 0.90 0.89 0.90 0.94 0.92
0.82 0.87 0.79 0.86 0.79 0.89 0.93 0.83 0.92 0.91
0.86 0.80 0.81 0.90 0.68 0.80 0.85 0.90 0.87 0.79
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

ure 7.—Wind stress constancy for June. The plotted values are defined as the ratios of the vector means to the scalar means. The contour interval is 0.25.

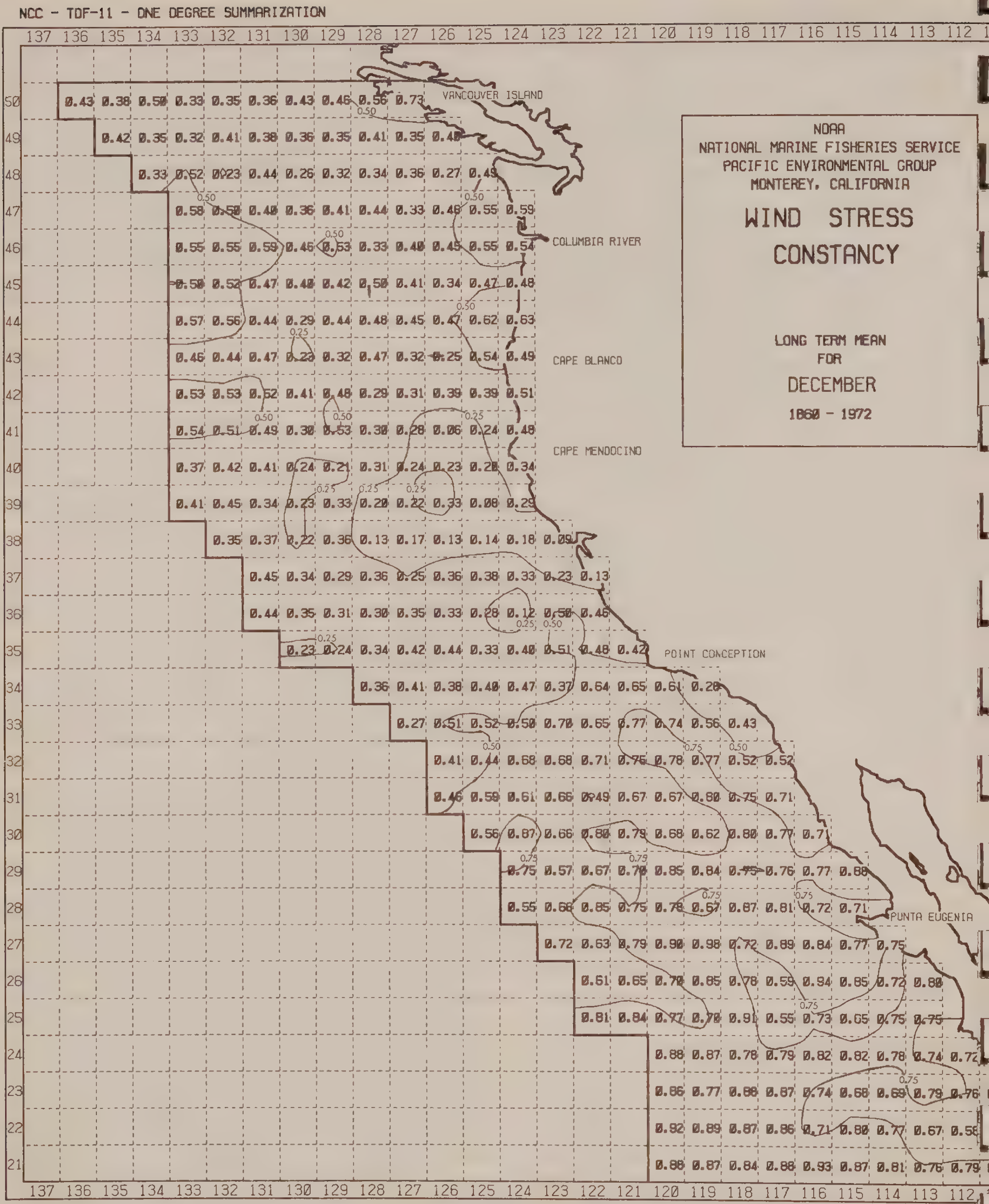
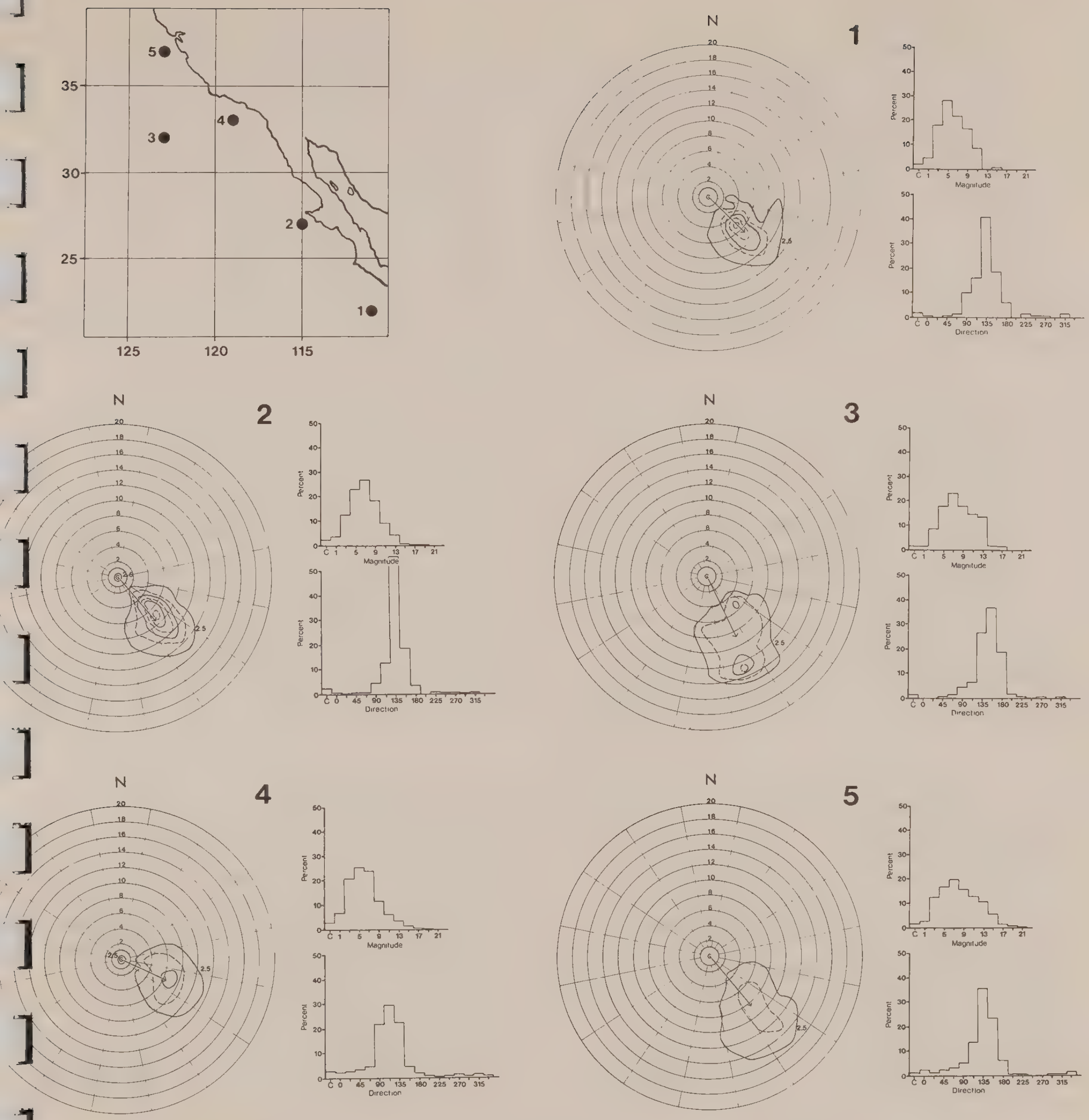

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 0.43 0.38 0.50 0.33 0.35 0.36 0.43 0.46 0.56 0.73
49 0.42 0.35 0.32 0.41 0.38 0.36 0.35 0.41 0.35 0.40
48 0.33 0.52 0.23 0.44 0.26 0.32 0.34 0.36 0.27 0.49
47 0.58 0.50 0.40 0.36 0.41 0.44 0.33 0.46 0.55 0.59
46 0.55 0.55 0.59 0.46 0.53 0.33 0.40 0.45 0.55 0.54
45 0.50 0.52 0.47 0.40 0.42 0.50 0.41 0.34 0.47 0.48
44 0.57 0.56 0.44 0.29 0.44 0.48 0.45 0.47 0.62 0.63
43 0.46 0.44 0.47 0.23 0.32 0.47 0.32 0.25 0.54 0.49
42 0.53 0.53 0.52 0.41 0.48 0.29 0.31 0.39 0.39 0.51
41 0.54 0.51 0.49 0.30 0.53 0.30 0.28 0.06 0.24 0.48
40 0.37 0.42 0.41 0.24 0.21 0.31 0.24 0.23 0.20 0.34
39 0.41 0.45 0.34 0.23 0.33 0.20 0.22 0.33 0.08 0.29
38 0.35 0.37 0.22 0.36 0.13 0.17 0.13 0.14 0.18 0.09
37 0.45 0.34 0.29 0.36 0.25 0.36 0.38 0.33 0.23 0.13
36 0.44 0.35 0.31 0.30 0.35 0.33 0.28 0.12 0.50 0.46
35 0.23 0.24 0.34 0.42 0.44 0.33 0.40 0.51 0.48 0.42
34 0.36 0.41 0.38 0.40 0.47 0.37 0.64 0.65 0.61 0.20
33 0.27 0.51 0.52 0.50 0.70 0.65 0.77 0.74 0.56 0.43
32 0.41 0.44 0.68 0.68 0.71 0.76 0.78 0.77 0.52 0.52
31 0.46 0.59 0.61 0.66 0.49 0.67 0.67 0.80 0.75 0.71
30 0.56 0.87 0.66 0.80 0.79 0.68 0.62 0.80 0.77 0.71
29 0.75 0.57 0.67 0.70 0.85 0.84 0.75 0.76 0.77 0.88
28 0.55 0.66 0.85 0.75 0.78 0.67 0.87 0.81 0.72 0.71
27 0.72 0.63 0.79 0.90 0.98 0.72 0.89 0.84 0.77 0.75
26 0.61 0.65 0.70 0.85 0.78 0.59 0.94 0.85 0.72 0.80
25 0.81 0.84 0.77 0.70 0.91 0.55 0.73 0.65 0.75 0.75
24 0.88 0.87 0.78 0.79 0.82 0.82 0.78 0.74 0.72
23 0.86 0.77 0.88 0.87 0.74 0.68 0.69 0.79 0.76
22 0.92 0.89 0.87 0.86 0.71 0.80 0.77 0.67 0.58
21 0.88 0.87 0.84 0.88 0.93 0.87 0.81 0.76 0.79
0.25
0.50
0.75
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS CONSTANCY
LONG TERM MEAN
FOR
DECEMBER
1860 - 1972
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112

Figure 8.—Wind stress constancy for December. The plotted values are defined as the ratios of the vector means to the scalar means. The
interval is 0.25.



re 9.—Relative frequency surfaces and frequency histograms for June. Data are shown for the 1-degree squares labelled 1 through 5 in the upper left inset. Contours of relative frequency are drawn at intervals of 2.5%. Mean vector wind stress is indicated by an arrow.

nths. A slight shift in direction and magnitude of the
d stress is indicated between summer and winter.
ean stress in December is directed more toward the
and the magnitude has decreased.

he frequency histograms also show these features.
ring June, the direction histogram is characteris-
narrow-banded. Over 70% of the observations may
centrated within three direction intervals. In
cember, the observations tend to be spread over a
ler range of directions. The histograms are broader
e peaks in direction are less well-defined. Peak
udes in June are generally one class interval larger
than peak magnitudes in December. However, the winter distributions are characterized by an increase in relative frequency at high values of wind stress magnitude.

A similar pattern of contrasts between summer and winter distributions is apparent in the northern section of the grid. As shown in Figures 11 and 12, the direction histograms are generally well-defined during the summer, although bimodal distributions are evident. During winter, observations are nearly uniformly spread among all directions. There is a lack of consistency in the frequency surfaces in Figure 12. Direction histograms for

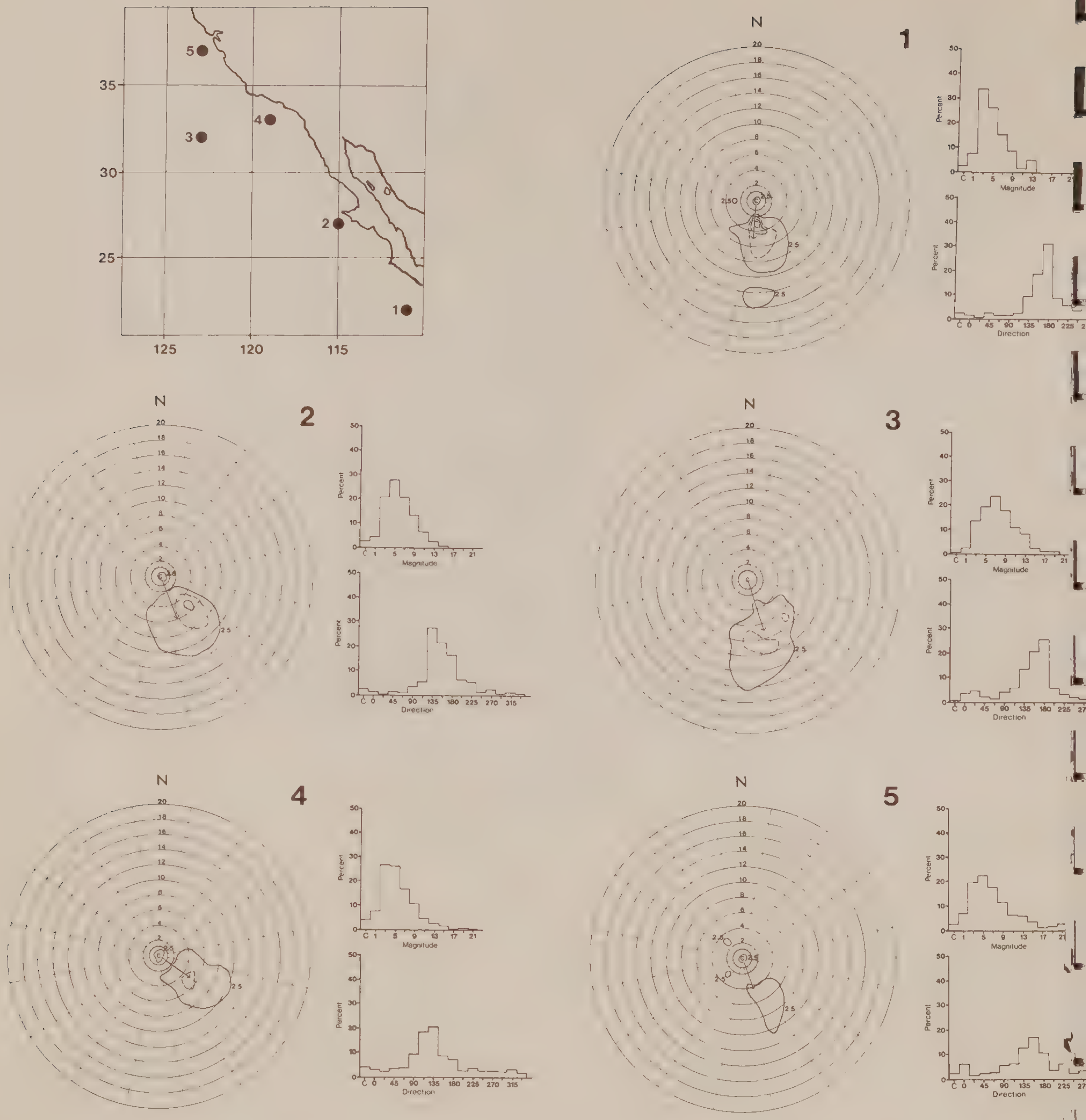
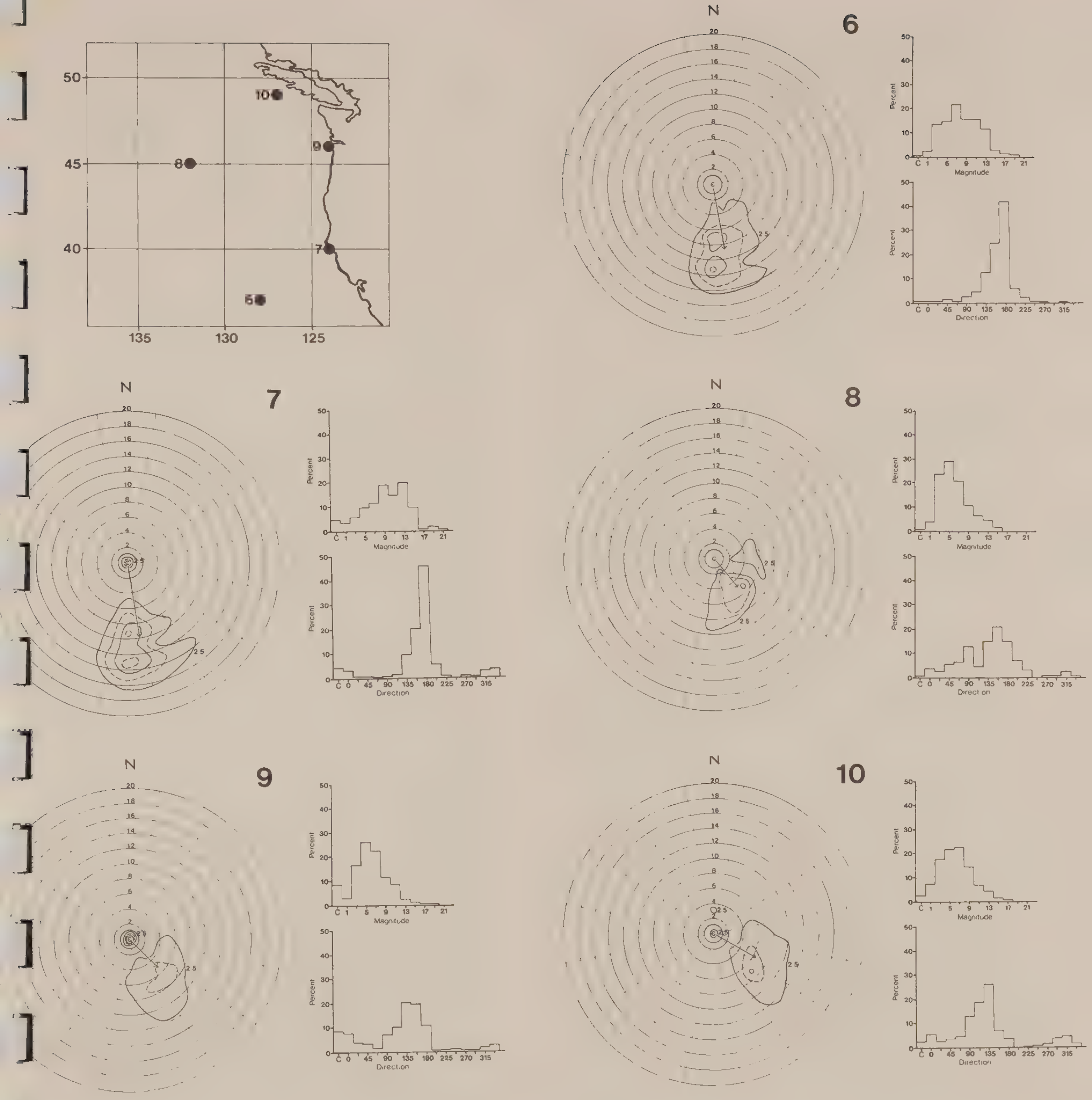


Figure 10.—Relative frequency surfaces and frequency histograms for December. Data are shown for the 1-degree squares labelled 1 through the upper left inset. Contours of relative frequency are drawn at intervals of 2.5%. Mean vector wind stress is indicated by an arrow

January are broad and flat and the peaks which generally characterize the summer distributions are missing. Mean directions shift from equatorward to poleward between summer and winter. A complete reversal in the mean direction occurs at point 7 (Figs. 11, 12). A shift in magnitude is equally pronounced. Peak magnitudes are higher in January than in July indicating a greater contribution of high wind speeds in January.

The above discussion adds a new dimension to the seasonal descriptions of the surface wind stress distributions over the California Current. Pronounced seasonal variations in magnitude and direction of monthly mean wind stress are indicated along the west coast of the United States. These changes ar evident off the coasts of Oregon and Washington. In dition, these data suggest month to month changes in large-scale spatial variability. Frequency histogra direction and magnitude are broad and flat duri winter months, and along the northern coast. W defined peaks in magnitude and direction character the distributions during the summer and alon southern coast.



ure 11.—Relative frequency surfaces and frequency histograms for July. Data are shown for the 1-degree squares labelled 6 through 10 in the upper left inset. Contours of relative frequency are drawn at intervals of 2.5%. Mean vector wind stress is indicated by an arrow.

nal Cycle at the Coast

Ti e series of the surface wind stress within the 1- square areas immediately adjacent to the coast e displayed in Figure 13 as the alongshore component, d in Figure 14 as the onshore component. For these dis- the vector means have been resolved into com- s parallel and perpendicular to the coast. The astline angles were determined by visually fitting a e to the dominant trend of the coast within each 1- square. The months are indicated along the tops figures. The latitudes of the 1-degree squares are indicated on the right and left sides of the figures. Negative values are shaded and indicate equatorward alongshore stress in Figure 13 and offshore stress in Figure 14.

Several characteristic features are apparent in these figures. South of lat. 40°N there is an equatorward component throughout the year, implying conditions favorable for coastal upwelling in all months. Off the coasts of Oregon and Washington, the data suggest that upwelling occurs seasonally between the months of April and September.

Three relative maxima occur in the time/space domain. Off the coast of Baja California, maximum values

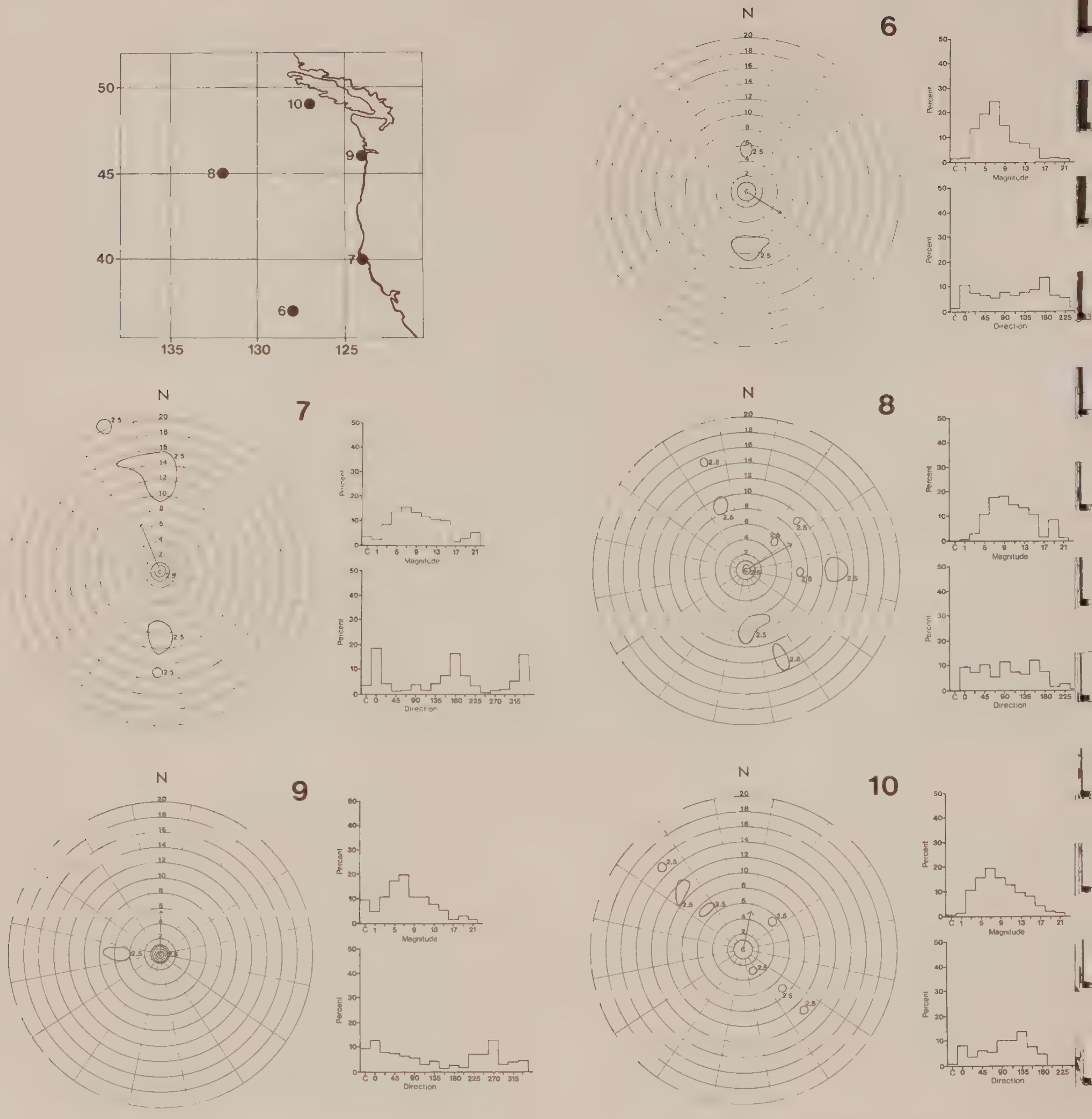


Figure 12.—Relative frequency surfaces and frequency histograms for January. Data are shown for the 1-degree squares labelled 6 throu the upper left inset. Contours of relative frequency are drawn at intervals of 2.5%. Mean vector wind stress is indicated by an arro

of wind stress are evident near Punta Eugenia in May. A large maximum occurs just south of Cape Mendocino between May and August. A smaller, local maximum occurs in May and June at lat. 36°N.

Figure 13 is similar in appearance to a time series of offshore Ekman transport shown by Bakun et al. (1974). They showed a good correlation between the occurrence of maximum offshore transport at lat. 39°N and a suppression of seasonal warming in the adjacent coastal waters during early summer, which is indicative of upwelling. The timing of the central wind stress maximum off the coast from Cape Mendocino agrees with the description of the mean yearly cycle of indicated upwelling given by Bakun (1973). However, Bakun' are spatially distorted, and indicate maximum val lat. 33°N, long. 119°W in the middle of the Sout California Bight. The spatial distortion is pri caused by development of an intense thermal lo southern California during the summer. The influen this low pressure system, and the effects of coastal m tain ranges distort the analyzed pressure fields u Bakun's computations.

The time series of alongshore surface wind stress 13) suggests a slight tilt, with time and space, to region of maximum values. This corresponds to a ward shift in the intensity of the surface wind stres

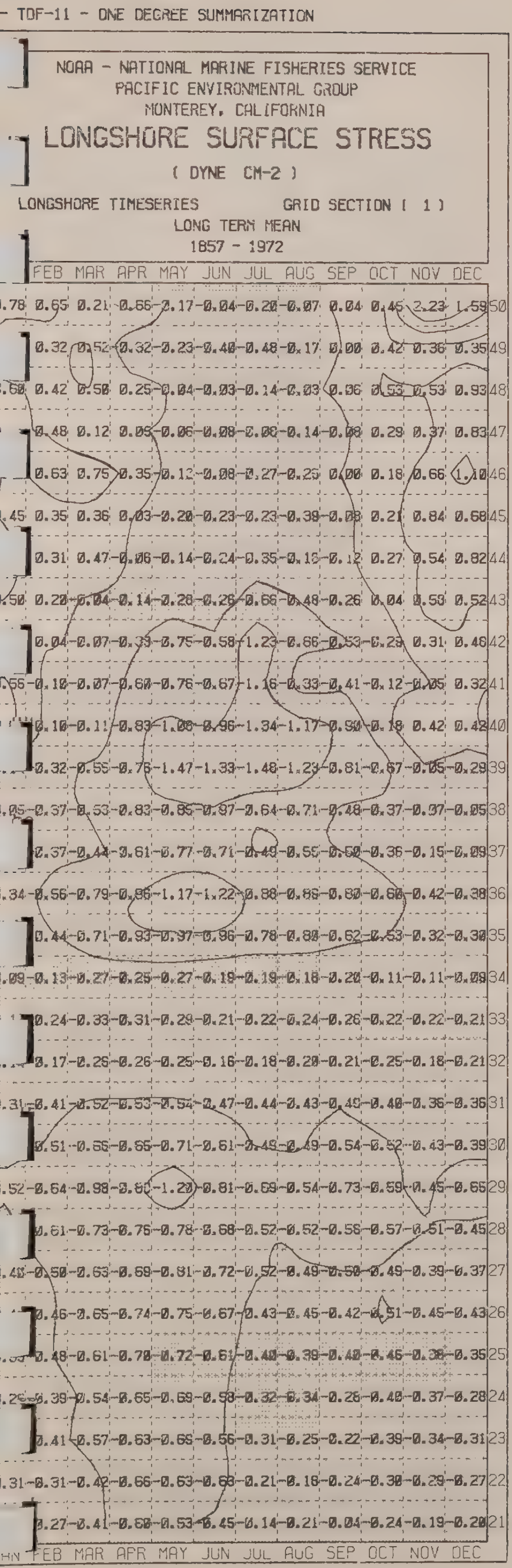


Figure 13.—Seasonal cycle of alongshore surface wind stress near the coast. Means of the alongshore components of wind stress were computed by month for the 1-degree squares immediately adjacent to the coast. Units are dyne cm^{-2}. The contour interval is 0.5 dyne cm^{-2}. Equatorward alongshore stress is shaded. Numbers along ordinate are degrees north latitude.

April and May off the coast of Baja California to June, July, and August off Cape Mendocino and Cape Blanco.

Figure 14 indicates a tendency for the surface wind stress to be directed onshore throughout the year north of lat. 30°N. Off the coast of Baja California, surface stress is characterized by offshore components, except between the months of April and October. Offshore components are also apparent in the vicinity of Cape Mendocino and Point Conception. Near these points, abrupt changes in coastline orientation may influence the direction and magnitude of the surface wind stress.

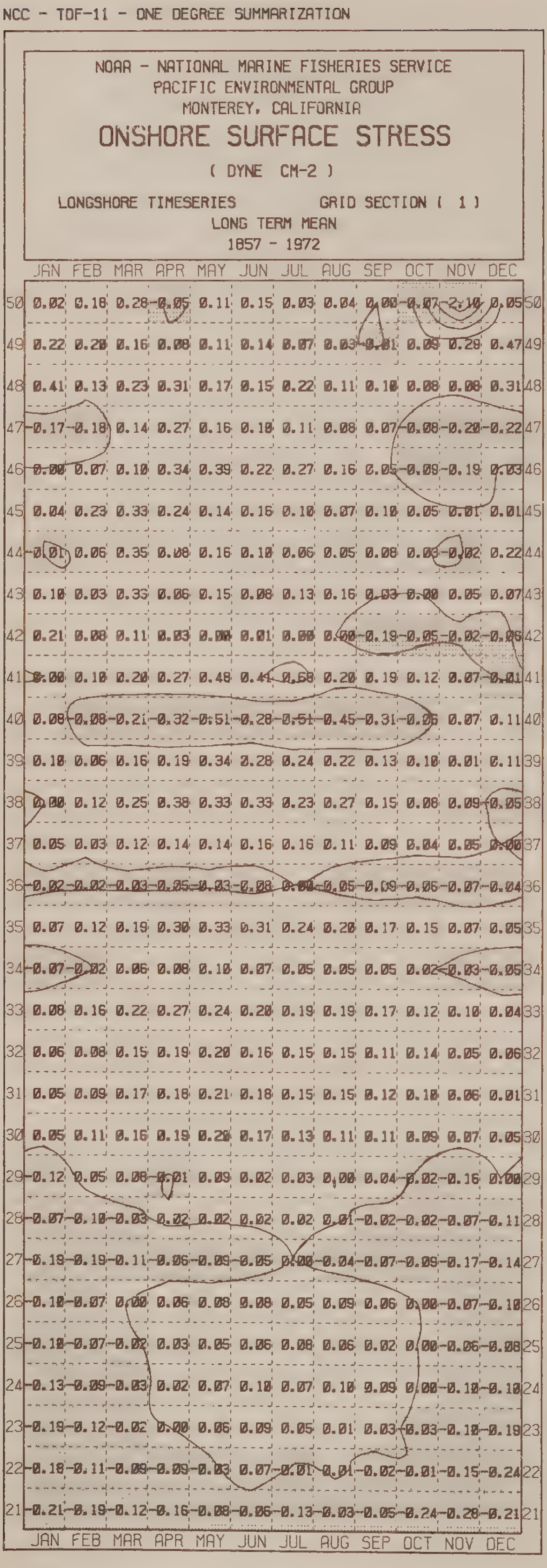
WIND STRESS CURL

The surface wind stress curl is the forcing function for the vertically integrated mass transport of the wind-driven ocean circulation. Under linear, steady-state conditions on the "β-plane," in the absence of friction and interactions with bottom topography, the meridional component of mass transport (M_y) is directly proportional to the vertical component of the curl of the wind stress as expressed in Equation (6):

$$M_y = \frac{\vec{k} \cdot (\nabla \times \vec{\tau})}{\beta} \qquad (6)$$

where M_y is the meridional component of the vertically integrated mass transport, β is the meridional derivative of the Coriolis parameter f, and $\vec{k} \cdot (\nabla \times \vec{\tau})$ is the vertical component of the wind stress curl. According to the simplified model, positive (negative) wind stress curl is associated with northward (southward) meridional transport. Surface Ekman divergence (convergence) corresponding to positive (negative) wind stress curl is balanced by geostrophic convergence (divergence) in the northward (southward) meridional flow.

Coastal upwelling occurs only at the ocean boundary. However, wind induced upwelling will occur whenever divergence in the surface wind drift is not balanced by other modes of horizontal surface flow. Figure 15 shows a mechanism by which the wind stress curl determines the divergent or convergent nature of the surface wind drift offshore of the primary coastal upwelling zone. A seaward increase in the equatorward wind stress parallel to the coast (Fig. 15A) is characterized by positive wind stress curl. In this situation, the offshore component of Ekman transport increases in the offshore direction, resulting in continued surface divergence. Upwelling is required to maintain the mass balance. If the equatorward longshore surface wind stress decreases in the offshore direction (Fig. 15B), the wind stress curl is negative. Convergence in the surface wind drift will result. Frontal formation and downwelling may occur just offshore of the primary coastal upwelling zone.



NCC - TDF-11 - ONE DEGREE SUMMARIZATION

NOAA - NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
ONSHORE SURFACE STRESS
(DYNE CM-2)
LONGSHORE TIMESERIES GRID SECTION (1)
LONG TERM MEAN
1857 - 1972

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
50	0.02	0.18	0.28	-0.05	0.11	0.15	0.03	0.04	0.00	-0.07	-2.10	0.05	50
49	0.22	0.20	0.16	0.08	0.11	0.14	0.07	0.03	-0.01	0.09	0.28	0.47	49
48	0.41	0.13	0.23	0.31	0.17	0.15	0.22	0.11	0.10	0.08	0.08	0.31	48
47	-0.17	-0.18	0.14	0.27	0.16	0.18	0.11	0.08	0.07	-0.08	-0.20	-0.22	47
46	0.00	0.07	0.10	0.34	0.39	0.22	0.27	0.16	0.05	-0.08	-0.19	0.03	46
45	0.04	0.23	0.33	0.24	0.14	0.16	0.10	0.07	0.10	0.05	0.01	0.01	45
44	-0.01	0.06	0.35	0.08	0.16	0.10	0.06	0.05	0.08	0.03	-0.02	0.22	44
43	0.10	0.03	0.33	0.06	0.15	0.08	0.13	0.16	0.03	0.00	0.05	0.07	43
42	0.21	0.08	0.11	0.03	0.00	0.01	0.00	0.00	-0.19	-0.05	-0.02	-0.06	42
41	0.00	0.10	0.20	0.27	0.48	0.44	0.68	0.20	0.19	0.12	0.07	-0.01	41
40	0.08	-0.08	-0.21	-0.32	-0.51	-0.28	-0.51	-0.45	-0.31	-0.06	0.07	0.11	40
39	0.10	0.06	0.16	0.19	0.34	0.28	0.24	0.22	0.13	0.10	0.01	0.11	39
38	0.00	0.12	0.25	0.38	0.33	0.33	0.23	0.27	0.15	0.08	0.09	-0.05	38
37	0.05	0.03	0.12	0.14	0.14	0.16	0.16	0.11	0.09	0.04	0.05	0.00	37
36	-0.02	-0.02	-0.03	-0.05	-0.03	-0.08	0.00	-0.05	-0.09	-0.06	-0.07	-0.04	36
35	0.07	0.12	0.19	0.30	0.33	0.31	0.24	0.20	0.17	0.15	0.07	0.05	35
34	-0.07	-0.02	0.06	0.08	0.10	0.07	0.05	0.05	0.05	0.02	-0.03	-0.05	34
33	0.08	0.16	0.22	0.27	0.24	0.20	0.19	0.19	0.17	0.12	0.10	0.04	33
32	0.06	0.08	0.15	0.19	0.20	0.16	0.15	0.15	0.11	0.14	0.05	0.06	32
31	0.05	0.09	0.17	0.18	0.21	0.18	0.15	0.15	0.12	0.10	0.06	0.01	31
30	0.05	0.11	0.16	0.19	0.20	0.17	0.13	0.11	0.11	0.09	0.07	0.05	30
29	-0.12	0.05	0.08	-0.01	0.09	0.02	0.03	0.00	0.04	-0.02	-0.16	0.00	29
28	-0.07	-0.10	-0.03	0.02	0.02	0.02	0.02	0.01	-0.02	-0.02	-0.07	-0.11	28
27	-0.19	-0.19	-0.11	-0.06	-0.09	-0.05	0.00	-0.04	-0.07	-0.09	-0.17	-0.14	27
26	-0.10	-0.07	0.00	0.06	0.08	0.08	0.05	0.09	0.06	0.00	-0.07	-0.10	26
25	-0.10	-0.07	-0.02	0.03	0.05	0.06	0.08	0.06	0.02	0.00	-0.06	-0.08	25
24	-0.13	-0.09	-0.03	0.02	0.07	0.10	0.07	0.10	0.09	0.00	-0.10	-0.10	24
23	-0.19	-0.12	-0.02	0.00	0.06	0.09	0.05	0.01	0.03	-0.03	-0.10	-0.19	23
22	-0.18	-0.11	-0.09	-0.09	-0.03	0.07	-0.01	0.01	-0.02	-0.01	-0.15	-0.24	22
21	-0.21	-0.19	-0.12	-0.16	-0.08	-0.06	-0.13	-0.03	-0.05	-0.24	-0.28	-0.21	21
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	

Figure 14.—Seasonal cycle of onshore surface wind stress ne coast. Means of the onshore components of wind stress were c puted by month for the 1-degree squares immediately adjacent to coast. Units are dyne cm^{-2}. The contour interval is 0.5 dyne Offshore stress is shaded. Numbers along ordinate are degrees latitude.

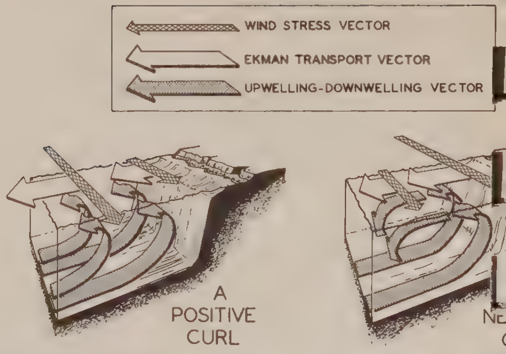


Figure 15.—A conceptual diagram of the relationship of wi curl to the divergence and convergence of surface Ekman t offshore of the primary coastal upwelling zone.

Direct measurements of wind stress curl a available; however, the curl of the monthly me face wind stress fields has been computed. The ve component of the curl of the wind stress in sph coordinates is defined by:

$$\overrightarrow{k}\cdot(\nabla\times\overrightarrow{\overline{\tau}}) = \frac{1}{R\cos\varphi}\left[\frac{\partial\overline{\tau}_y}{\partial\lambda} - \frac{\partial}{\partial\varphi}(\overline{\tau}_x\cos\varphi)\right.$$

where R is the radius of the earth, φ and λ den graphic latitude and longitude, respectively, and $\overline{\tau}$ $\overline{\tau}_y$ denote the eastward and northward component mean surface wind stress. A finite difference e approximating the curl at the grid point (i, j) in Fi is given by:

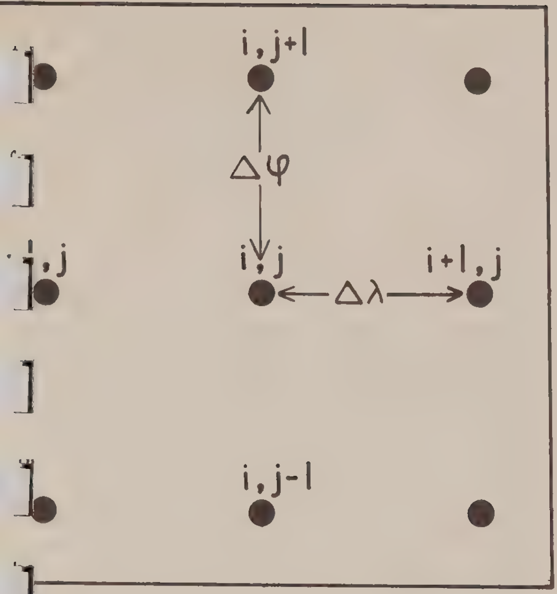
$$\overrightarrow{k}\cdot(\nabla\times\overrightarrow{\overline{\tau}}_{i,j}) = \frac{1}{R\cos\varphi_{i,j}}\left[\frac{\overline{\tau}_{y_{i+1,j}} - \overline{\tau}_{y_{i-1,j}}}{2\Delta\lambda}\right.$$

$$-\left(\frac{(\overline{\tau}_x\cos\varphi)_{i,j+1} - (\overline{\tau}_x\cos\varphi)_{i,j-}}{2\Delta\varphi}\right.$$

where $\Delta\varphi = \Delta\lambda = 1°$. The method is similar to tions described by Hantel (1970). Centered diff were utilized throughout the interior of the data Forward and backward differences were require the boundaries. As a result, certain artificial may have been introduced at these boundaries.

Monthly Curl Distributions

Monthly fields of surface wind stress curl ar played in Appendix III (Charts 37 to 48). Th tributions correspond to the monthly mean win distributions shown in Appendix I. Values are plot units of dyne cm^{-2} per 100 km. A value of 1 dyn



ure 16.—Discretization grid used in calculating the wind stress curl.

0 km is equivalent to 1 × 10^{-7} dyne cm^{-3}. Negative lues of wind stress curl are shaded.

Small scale features evident in these distributions l be viewed with caution. Detail within a single 1- e square area which is not supported by similar lues in surrounding squares probably reflects "noise" th monthly means of surface wind stress. Objective hing procedures applied to the monthly mean wind ess fields would result in more homogeneous dis- butions of wind stress curl. A particular method has described by Evenson and Veronis (1975).

racteristic absolute magnitudes of the spatially eraged wind stress curl are 1 × 10^{-8} dyne cm^{-3}. This lue is approximately a factor of two less than the sum- e mean reported by Halpern (1976) for an up- g region near the Oregon coast. Considering the e and space averages used in the present study, this ference appears to be reasonable. However, the values nsistent with wind stress curl calculations reported unders (1976). The probable errors associated with ese estimates of wind stress curl may be calculated knowledge of the spatial distributions of standard of the (wind stress) component means (see Appen-). On average, the expected error is 1 × 10^{-8} dyne $^{-3}$, with maximum and minimum errors of 4 × 10^{-8} m^{-3} and 1 × 10^{-10} dyne cm^{-3}, respectively. Of , these values apply to particular individual 1- gree squares. Large values generally correspond to les" in the distributions, which are easily seen in the ly charts. For larger space scales, errors as- ed with the gradients of the mean wind stress com- nents would tend to cancel. Thus, greater confidence be expected for the patterns of wind stress curl are consistent over several degrees of latitude and de.

The large-scale features of positive and negative curl along the coast are significant. Important details to note are the sign of the wind stress curl at the coast, and the position of the line of zero wind stress curl. A general feature common to all months is the occurrence, on average, of positive wind stress curl near the coast, and negative curl at some distance offshore. This feature is well developed from May to September. Greater spatial variability is evident in winter distributions.

Existence of an offshore wind stress maximum results in a line of zero wind stress curl approximately parallel to the coast. Positive curl occurs inshore of the maximum wind stress. Negative curl in the offshore region is associated with the anticyclonic atmospheric circulation over the interior ocean. The positive curl near the coast is related to topography and to local features in the surface wind stress distributions.

The distributions from December to March are characterized by positive wind stress curl near the coast from San Francisco to northern Baja California, and south of Punta Eugenia. Large areas of associated Ekman divergence extend several hundred kilometers off the coast. The patterns of wind stress curl are less well behaved near the coasts of Oregon and Washington. However, negative wind stress curl near this coastal region appears to be typical of the distributions during the winter.

During spring and summer upwelling seasons, the dominant patterns of surface wind stress curl are easily recognized. The line of zero wind stress curl parallels the coast approximately 200 to 300 km offshore, along the entire boundary from northern Baja California to Vancouver Island, and from June through September. Yoshida and Mao (1957) placed this line at approximately 500 km from the coast. Considering the coarse resolution (5-degree squares of latitude and longitude) of their data, this disparity is not surprising.

The months of April-May and October-November appear as transitional periods. During transition from spring to summer, the negative curl along the coasts of Oregon and Washington shifts to positive curl. The offshore distribution takes on a more uniform character. Scattered regions of positive and negative curl are replaced by a large area of negative curl. The late fall transition is marked by a total breakdown in the curl distributions within the northern sector of the grid.

Several local (positive) curl maxima are associated with major topographic changes in the coastline configuration. Large values of positive wind stress curl are found near Cape Blanco, Cape Mendocino, San Francisco, and Point Conception. These features may be real, or they may be artifices of the finite difference calculations or the data distributions. However, one does note that near Point Conception, the values of positive wind stress curl are consistent with a decrease in the magnitude of the surface wind stress in the lee of the point. Where areas of positive wind stress curl extend offshore of capes, there would tend to be a continued, although much reduced, level of upwelling outside of the primary coastal upwelling regime.

A region of negative wind stress curl (Ekman convergence) reaches the coast of Baja California between Punta Eugenia and Punta Baja to the north. This feature appears consistently throughout the year. A partial breakdown in this system occurs in August, October, and November. However, considering the probable uncertainties in these derived data, one might reasonably conclude that the coastal region near Punta Eugenia can be characterized in the mean by convergence in the surface wind drift. The distributions of wind stress curl in this area imply favorable conditions for formation of fronts and convergent patches of recently upwelled water.

Coastal Time Series

The mean annual cycle of wind stress curl near the coast is shown in Figure 17. Positive wind stress curl occurs along most of the coast throughout the year. Exceptions to this generalization are found in the region south of lat. 30°N and between lat. 40°N and 47°N. The temporal persistence of the negative wind stress curl near Punta Eugenia (lat. 29°N) is clearly seen in this time series. A similar feature occurs near the tip of Baja California. Seasonal variation between positive and negative curl is apparent from Cape Mendocino to the Columbia River.

Yoshida and Mao (1957) presented evidence indicating that open-ocean upwelling is related to wind stress curl. This process is distinct from coastal upwelling which is primarily a boundary phenomenon. However, the two mechanisms are not totally independent. In regions where positive wind stress curl occurs, such as between lat. 30°N and 40°N throughout the year, and near the coasts of Oregon and Washington during the summer, ascending motion related to the wind-induced divergence offshore enhances the upwelling associated with the more dominant coastal divergence.

DISCUSSION

Monthly distributions of surface wind stress show an offshore maximum which progressively develops over a large extent of the California Current and shifts northward and intensifies from winter to summer. This process is a primary forcing function for coastal upwelling. Off Baja California, wind-induced surface divergence occurs on average throughout the year. Downwelling occurs near the coast of Vancouver Island, except during the restricted period between May and August when a small equatorward component of surface wind stress is observed.

The major seasonal variations in the magnitude and direction of the surface wind stress can be described

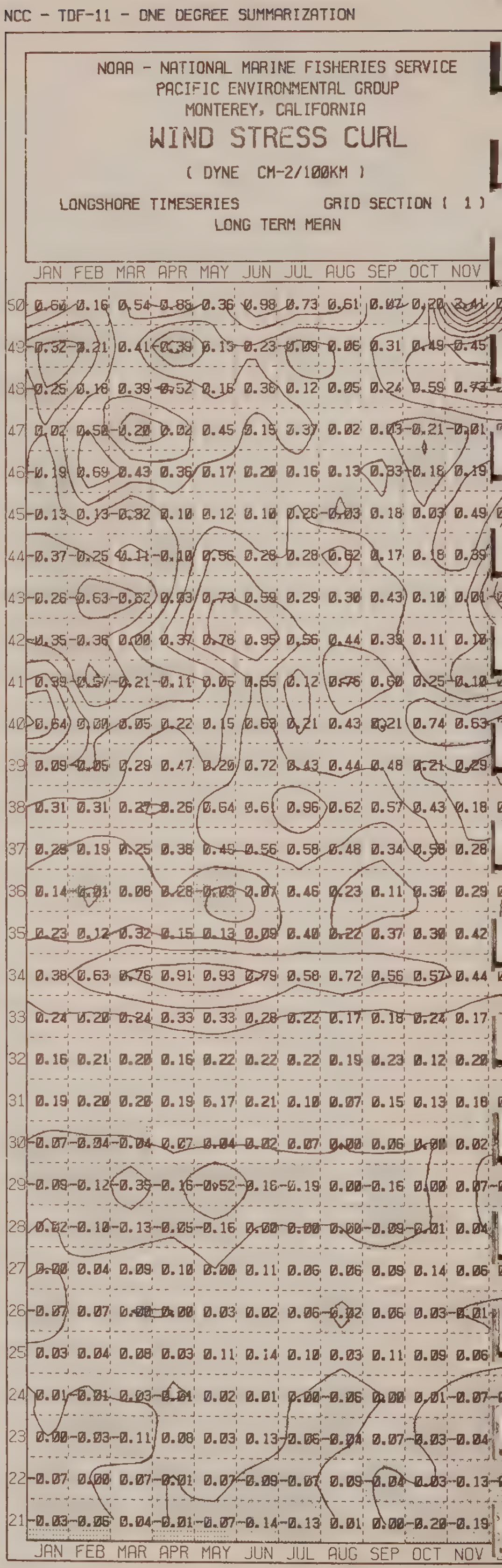


Figure 17.—Seasonal cycle of wind stress curl near the coast. The wind stress curl is shown by month for the 1-degree squares immediately adjacent to the coast. The calculations were based on the monthly mean surface wind stress distributions. Units are dyne cm^{-2} per 100 km. The contour interval is 0.25 dyne cm^{-2} per 100 km. Negative values are shaded. Numbers along ordinate are degrees north latitude.

nply in terms of the general atmospheric circulation er the northeast Pacific Ocean. Monthly mean surface ire charts typically show two well-developed pres- ells. A high pressure system over the ocean shifts rthward and increases in strength from winter to sum- r. The center of the cell moves in a northwestward ion. This shift in the large-scale anticyclonic cir- on results in the observed winter to summer rever- in the alongshore component of wind off the coasts of n and Washington. A low pressure system is ed over the southwestern United States. This nipermanent thermal low is fully developed over the ntral Valley in California during the summer. Cy- circulation associated with the low leads to orward surface wind stress parallel to the coast. e amplitude of the annual cycle is large. During win- , both of these pressure cells weaken. The high pres- ystem moves southward and the coasts of Oregon ashington come under the influence of the intense pressure system in the Gulf of Alaska.

primary mechanism controlling the location and th of the wind stress maximum and the associated stal upwelling is described by seasonal variations in gradient between the two pressure cells. During the , this gradient is weak. Strong heating over the ent during summer deepens the low and increases amplitude of the onshore-offshore pressure gradient. a result of the northward shift and strengthening of gh, and deepening of the low, the region of max- wind stress moves from the area south of Point nception to the vicinity of Cape Mendocino. These iations are, of course, a function of differential ocean- ent heating related to the annual cycle of solar on.

cal Implications

Climate of the adjacent coastal regions is influenced upwelling. During summer, the dome of high pres- hich develops over the North Pacific Ocean favors scale subsidence and a strong temperature inver- n over the west coast of the United States. This sup- deep cloud formation and greatly inhibits tation. Unpublished distributions of cloud cover,[6] nmarized from ship observations, show a large on- re-offshore gradient in the total cloud amount. a occur at the coast. The effect of the large-scale ence is noted in the true desert climate of Baja lifornia, and in the almost complete lack of rainfall ng the coasts of California, Oregon, and Washington the summer. Coastal upwelling primarily in- s the local climate of the nearshore zone within 10 20 km of the coast and contributes to the formation of atus clouds and fog typical of much of the coast California and Oregon.

A secondary mechanism may account for local intensification of surface wind stress and persistence of coastal upwelling over periods ranging from several weeks to a few months (Bakun 1974). In a simplified positive feedback model, wind stress parallel to the coast brings cold water to the surface and cools the adjacent air. The resulting temperature contrast between the continent and the ocean increases the local pressure gradient. Alongshore surface winds are increased and upwelling is enhanced (Ramage 1971). This mechanism may be slightly modified by the effect of atmospheric stability. In the summertime coastal upwelling zone, the air-sea temperature difference is usually positive. This stable stratification decreases the magnitude of the surface wind stress. The resulting negative feedback may partially offset the increase in surface winds associated with the described changes in the local pressure gradient.

The existence of maximum wind stress some 200 to 300 km from the coast is an interesting feature. Of course, a maximum in the onshore-offshore pressure gradient offshore may explain this phenomenon. Positive feedback associated with wind-induced upwelling extending hundreds of kilometers off the coast may act to intensify the alongshore winds. However, this feature also suggests a coastal boundary layer which acts to frictionally retard the winds near the coast, leading to a positive wind stress curl in the nearshore region.

A characteristic feature of the wind stress curl distributions is the occurrence of a line of zero curl at some distance from the coast. Observations show positive curl inshore of this line and negative curl in the offshore region. A theoretical analysis suggests that a poleward undercurrent along an eastern boundary is favored by positive wind stress curl along the coast and a poleward decrease in surface heating (Pedlosky 1974a). The monthly distributions of wind stress curl presented in this study are generally consistent with an equatorward Sverdrup flow offshore and a poleward Sverdrup flow near the coast, except in the region from Punta Eugenia to Punta Baja, where the wind stress curl is negative. The general pattern of positive wind stress curl along the coast and observations of the California Countercurrent (Wooster and Jones 1970; Wickham 1975) are consistent with Pedlosky's theory.

The Sverdrup transport balance expressed in Equation (6) may provide a simple and reasonable explanation for the existence of the current-countercurrent system observed along the west coast of the United States. Transport calculations, based on the July wind stress curl data for the line of 1-degree squares extending offshore of Cape Blanco (lat. 43°N), show a net southward transport of 3.5×10^{12} g s^{-1}. Within 300 km of the coast, an integrated northward transport of 2.2×10^{12} g s^{-1} is required. Negative wind stress curl between long. 127°W and 133°W is associated with a southward vertically integrated mass transport of 5.7×10^{12} g s^{-1}. These values underestimate, by a factor of two, the total volume transport of 10 sv (1 sverdrup = 10^6 m^3 s^{-1}) for the California Current suggested by Sverdrup et al. (1942:724).

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[6] butions of monthly mean cloud cover over the California Current e at Pacific Environmental Group, National Marine Fisheries NOAA, Monterey, CA 93940.

A relationship between wind stress curl and the California Current system has been suggested. The data indicate that the poleward undercurrent observed along the west coast of North America may be driven locally by positive wind stress curl. However, a possibility does exist that the boundary current is not entirely the result of local forcing. Coastal areas may respond to wavelike disturbances propagating from other regions of the ocean (Wyrtki 1975), or to other nonlocal processes (Pedlosky 1974b).

Biological Implications

Relationships among patterns of coastal and equatorial upwelling and distributions of primary production have been discussed by Cushing (1969). Favorable conditions for phytoplankton growth are maintained within surface photic layers by upwelling of nutrient-rich subsurface water. Offshore divergence related to the curl of the wind stress effectively extends the width of the biological upwelling zone. Fronts may form in areas of negative wind stress curl just offshore of the primary coastal convergence, such as near Punta Eugenia. These fronts would tend to concentrate both the available food and the grazers within the same areas. This process may be important to survival of fish stocks which spawn in this coastal region.

Seasonal changes in surface circulation may also provide mechanisms for survival and possible separation of stocks along the coast. The current-countercurrent system characteristic of southern California suggests a mechanism whereby pelagic fish could migrate seasonally from primary feeding grounds within the coastal upwelling regime off northern California to spawning grounds off Baja California.

A general requirement for vertically integrated northward Sverdrup transport along the coast apparently breaks down near Punta Eugenia where negative wind stress curl is observed (Fig. 18A). In this region, there must be southward vertically integrated Sverdrup transport.

With this consideration in mind, it is interesting to note the winter distribution of surface currents depicted in Figure 18B. The large-scale pattern suggests two separate cyclonic gyres associated with positive wind stress curl in the Southern California Bight, and south of Punta Eugenia. In the region of negative wind stress curl, the indicated surface flow is toward the south.

The importance of coastal upwelling, offshore divergence, and patterns of surface circulation to the early survival of larvae in the California Current region has been recognized (Anonymous 1952). The correspondences of features in the patterns of wind stress curl, surface currents, and winter distributions of the northern anchovy, *Engraulis mordax*, (Vrooman and Smith, 1971), shown in Figure 18C, are highly suggestive of larval transport mechanisms which could lead to formation of subpopulations of pelagic fishes in the California Current. These mechanisms have been described by

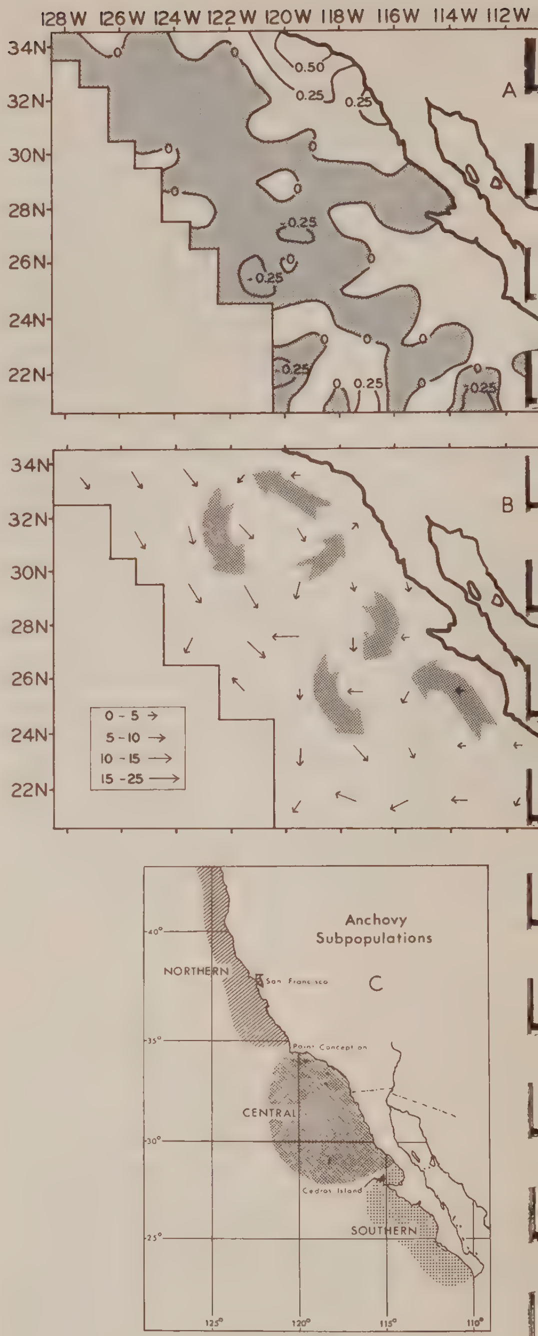

Figure 18.—Distributions of: A. wind stress curl, B. surf rents, and C. anchovy subpopulations. Wind stress curl is sh September. Units are dyne cm^{-2} per 100 km. The contour int 0.25 dyne cm^{-2} per 100 km. Negative values are shaded. The distribution of surface currents is depicted in terms of 2-deg marizations of ship drift data. Vector symbols are scaled acco the key on the chart. Units are cm s^{-1}. Large arrows suggest t cyclonic circulation which develops off southern California ar California. The winter distributions of the three subpopula northern anchovy are shown in the bottom figure. Figure C Vrooman and Smith (1971).

rrish (1976). Distributions of Pacific mackerel, *Scom-* r *japonicus*, are similar to those for central and ern subpopulations of northern anchovy shown in 18C.

CONCLUSIONS

The present study has demonstrated the utility of his- rical marine observations in describing details of sur- roperties over an area of the North Pacific Ocean. ution by 1-degree square and long-term month is asible when the amplitude of the seasonal cycle is ge. This method of summarization may fail in regions rse data, or in the tropics where long-term fluc- ns frequently obscure the seasonal cycle.

Summarization of these data by 1-degree square, nth, and year often fails to produce consistent time The resulting fields may not be statistically sig- nt if the mean values are based on too few obser- tions. Objective analysis provides a method to obtain tency in time and space. However, with these ds, continuity in time is gained at the expense of atial resolution. An empirical approach might be used calibrate the large-scale analyzed fields in terms of the es evident in higher resolution distributions, such se presented in this report. The resulting time ies could be related to fluctuations of marine logical communities which must respond to wide ions in environmental conditions on time scales g from a few days to several years.

ACKNOWLEDGMENTS

The author is indebted to Andrew Bakun for his ginal suggestions, constructive criticism, and con- encouragement throughout the course of this Gunter R. Seckel and David M. Husby provided aluable advice, many stimulating discussions, and iewed the completed manuscript. Grateful apprecia- extended to James H. Johnson for providing the unity to complete this research. All are colleagues the Pacific Environmental Group, National Marine heries Service, NOAA. Historical surface marine data lectronic computing and plotting facilities were ed by the U.S. Navy, Fleet Numerical Weather ntral.

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APPENDIX I

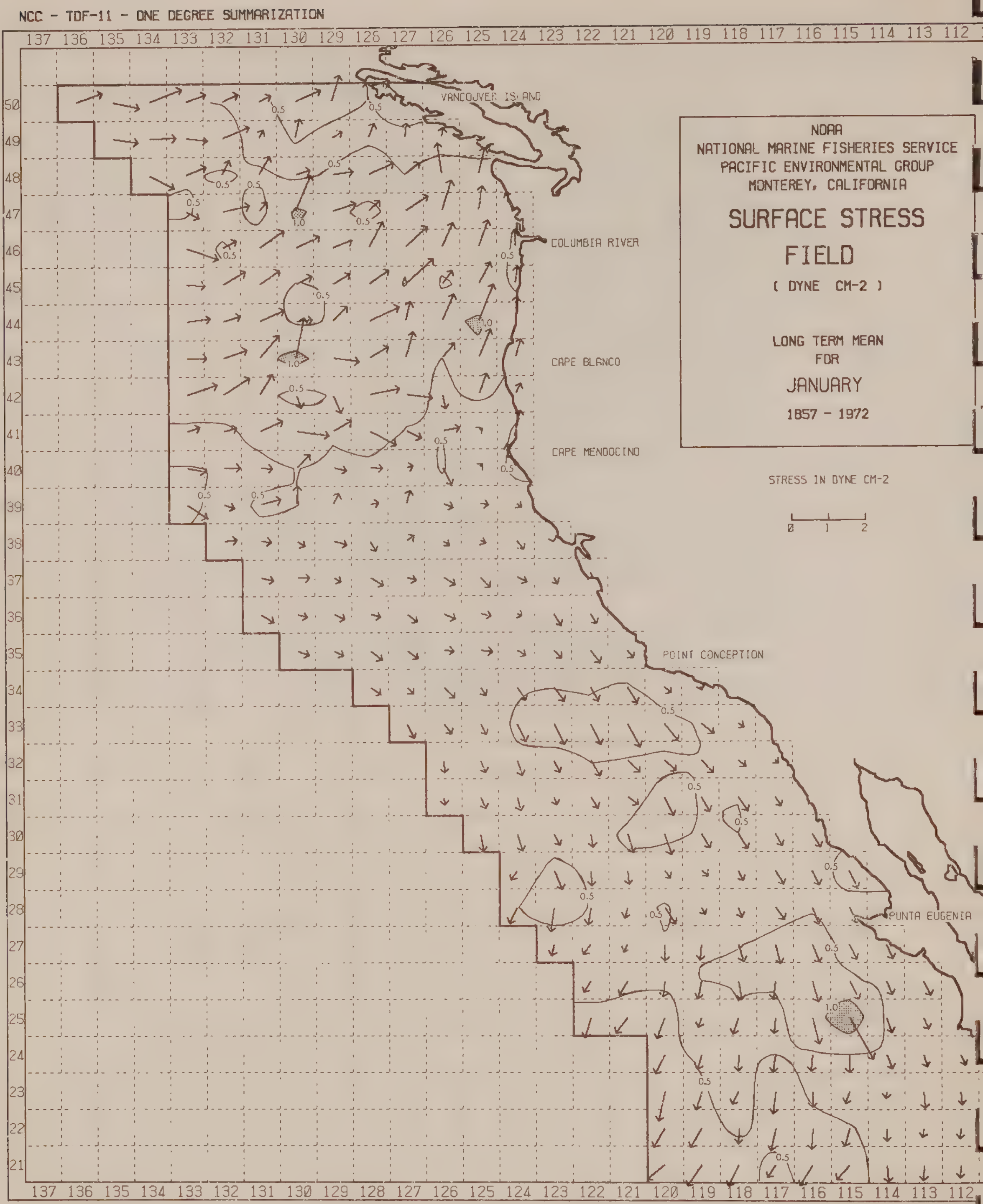
Monthly Surface Wind Stress Distributions

The long term composite monthly mean surface wind stress distributions are displayed in Charts 1 to 12 as resultant vectors, in Charts 13 to 24 as the eastward components, and in Charts 25 to 36 as the northward components. The values are plotted in units of dyne cm^{-2}. The month is indicated in the figure legend in the upper right corner of the charts. The two years displayed below the month, for example 1858-1972, correspond to the year of the earliest report and the year of the most recent report, respectively. The coastline configuration is superimposed on the grid as a visual aid and does not represent a conformal mapping.

In Charts 1 to 12, the vectors are plotted according to the scale shown below the figure legend. The mean vector magnitudes are contoured at intervals of 0.5 dyne cm^{-2}. Magnitudes greater than 1.0 dyne cm^{-2} are shaded.

Charts 13 to 24 display contoured values of the eastward component of the resultant surface wind stress. The contour interval is 0.5 dyne cm^{-2}. Positive values correspond to eastward components. Negative values are shaded.

The northward component of the resultant stress is plotted in Charts 25 to 36. The contour interval is 0.5 dyne cm^{-2}. Positive values correspond to northward components. Negative values are shaded.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VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.5
1.0
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
JANUARY
1857 - 1972
STRESS IN DYNE CM-2
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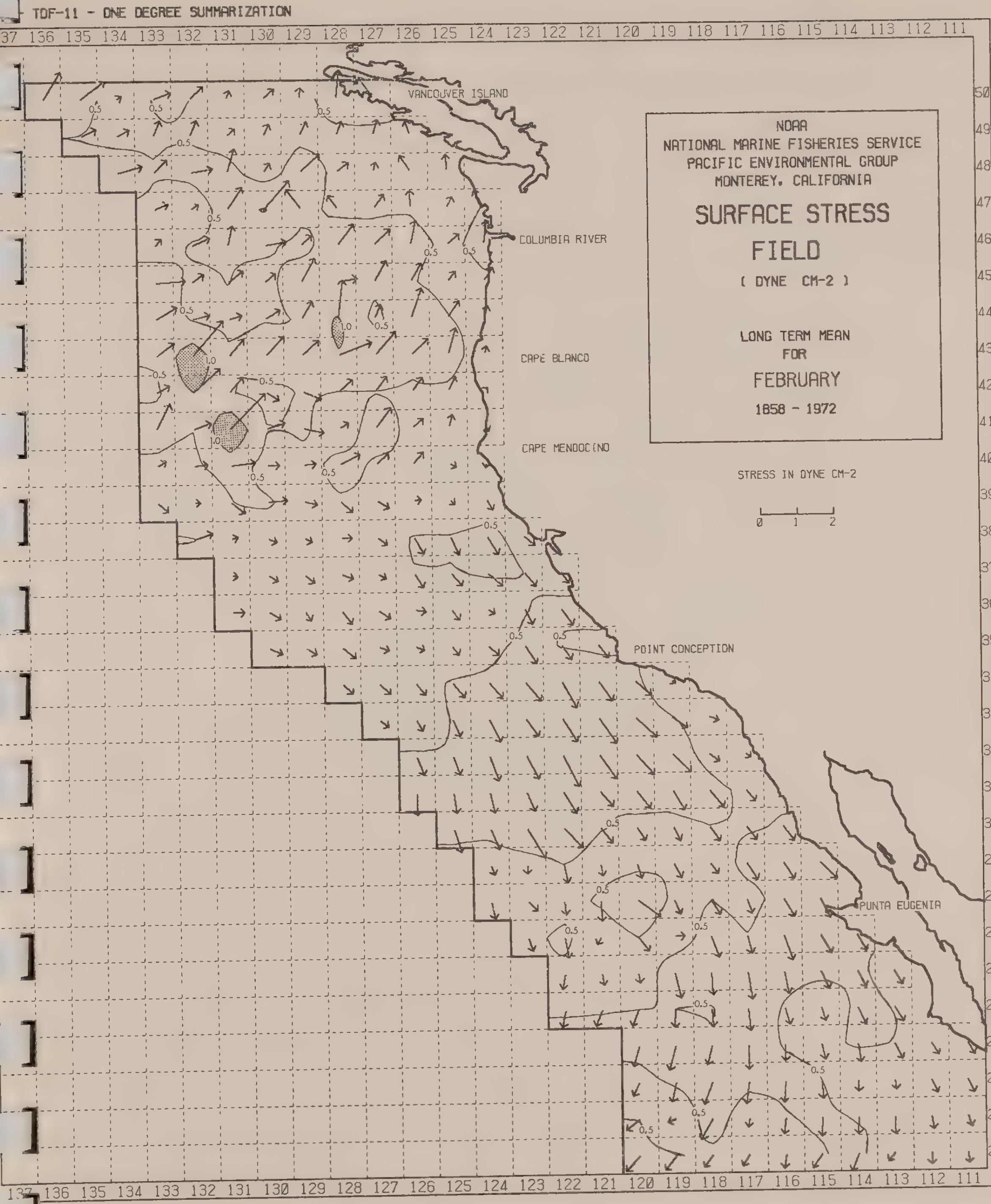
Chart 1.—Resultant surface wind stress vectors for January.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NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
FEBRUARY
1858 - 1972
STRESS IN DYNE CM-2
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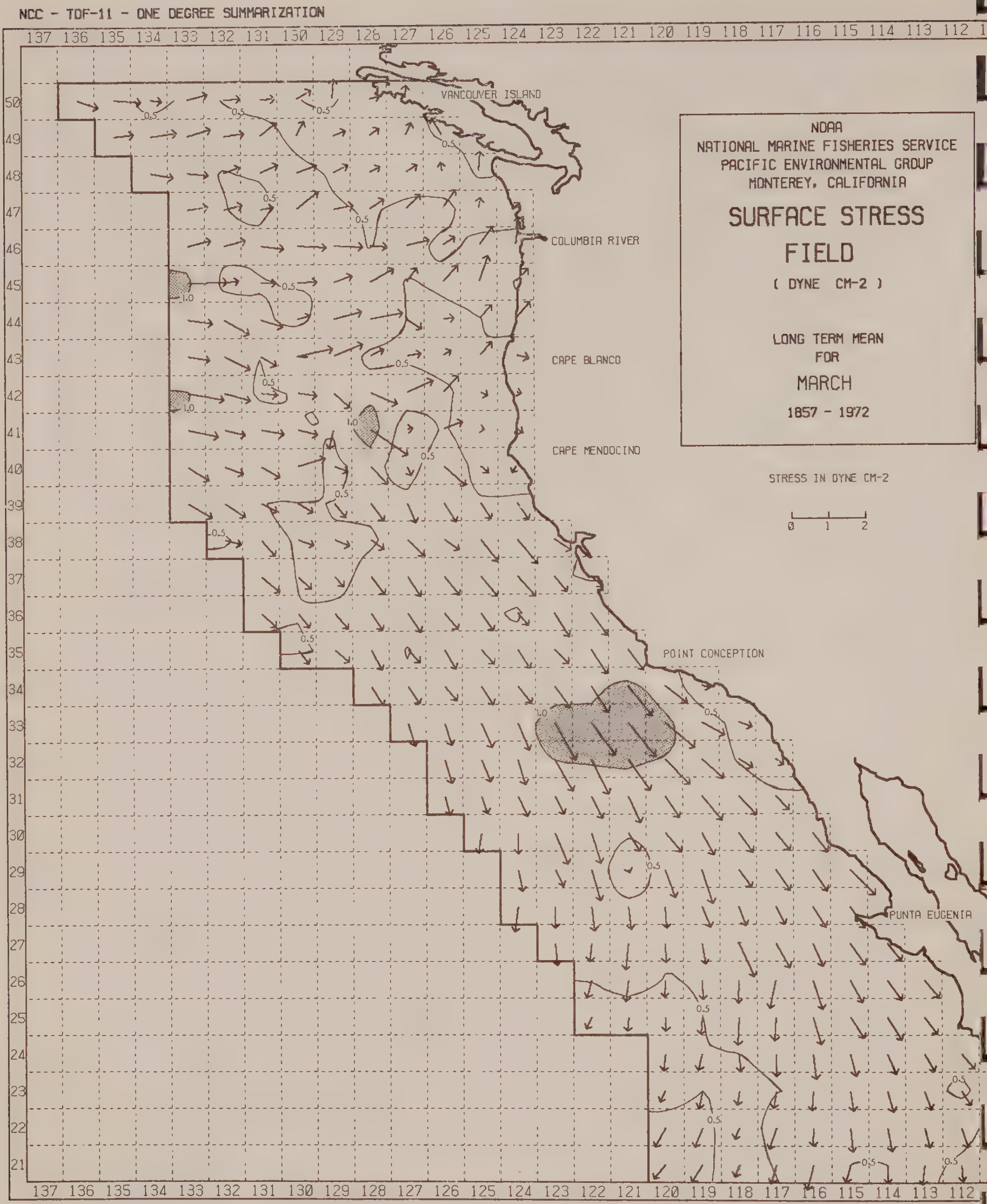
Chart 2.—Resultant surface wind stress vectors for February.


NCC - TDF-11 - ONE DEGREE SUMMARIZATION
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VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
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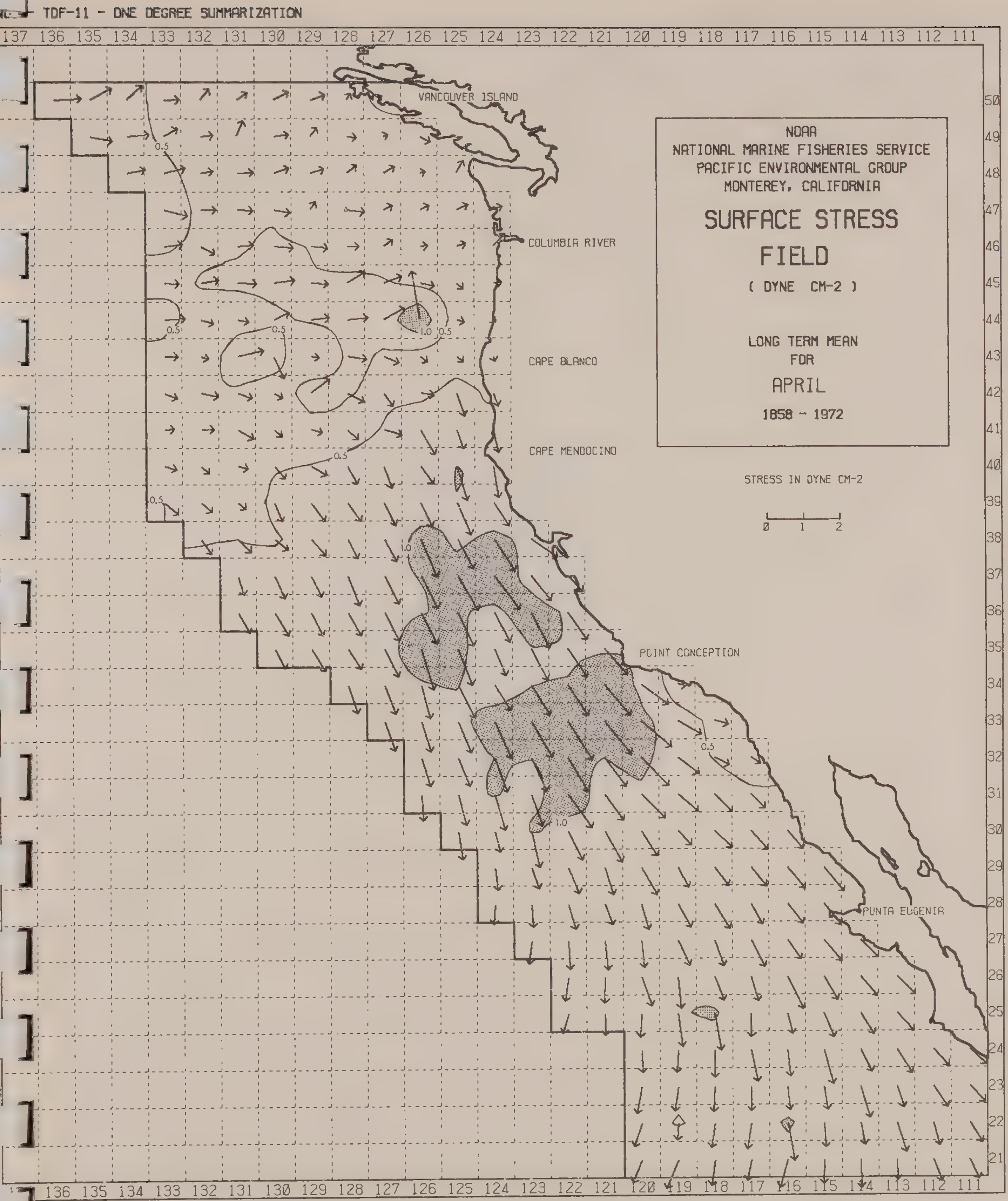
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
MARCH
1857 - 1972
STRESS IN DYNE CM-2
0 1 2

Chart 3.—Resultant surface wind stress vectors for March.


TDF-11 - ONE DEGREE SUMMARIZATION
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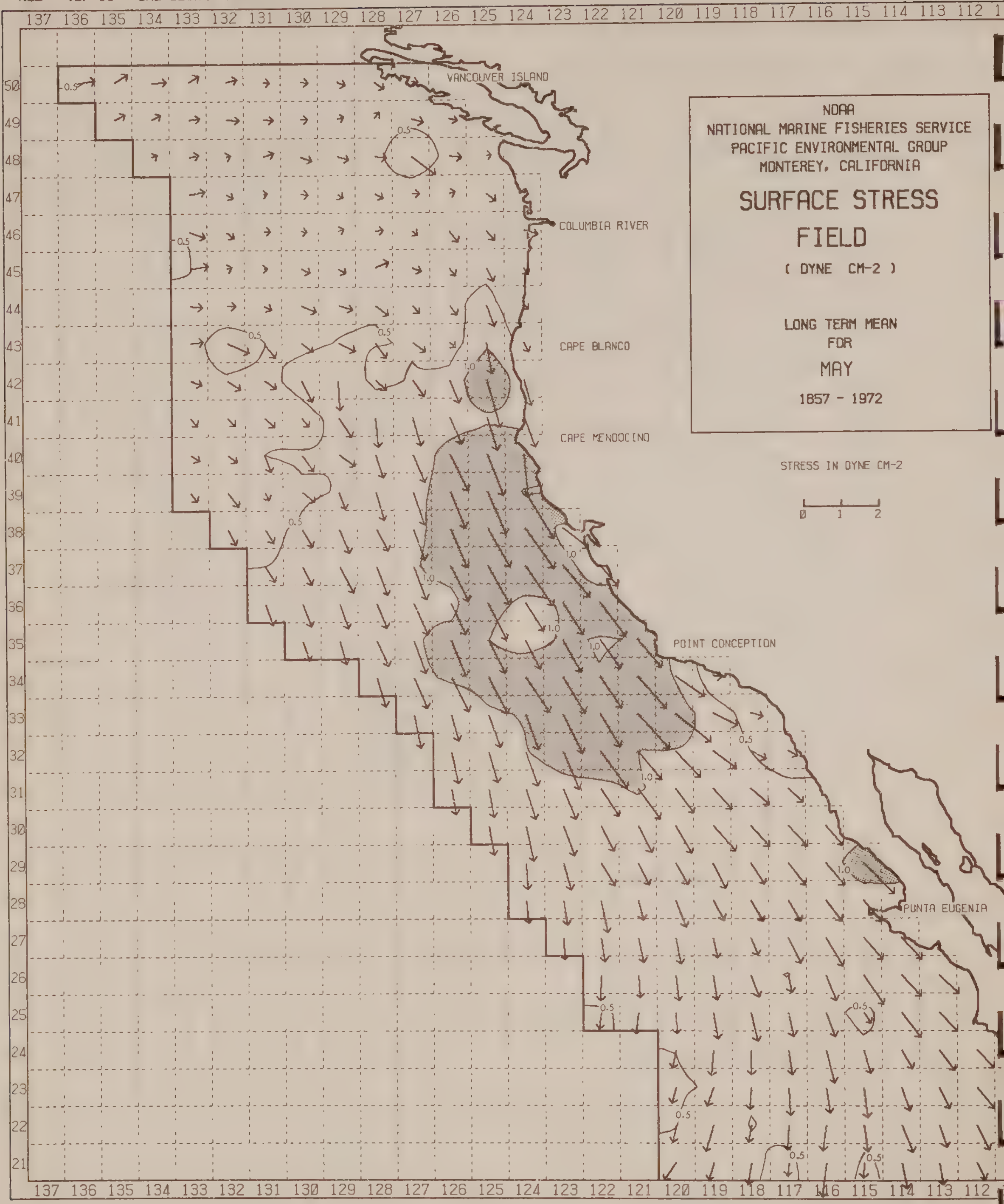
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.5
1.0
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
APRIL
1858 - 1972
STRESS IN DYNE CM-2
0 1 2

Chart 4.—Resultant surface wind stress vectors for April.

NCC - TDF-11 - ONE DEGREE SUMMARIZATION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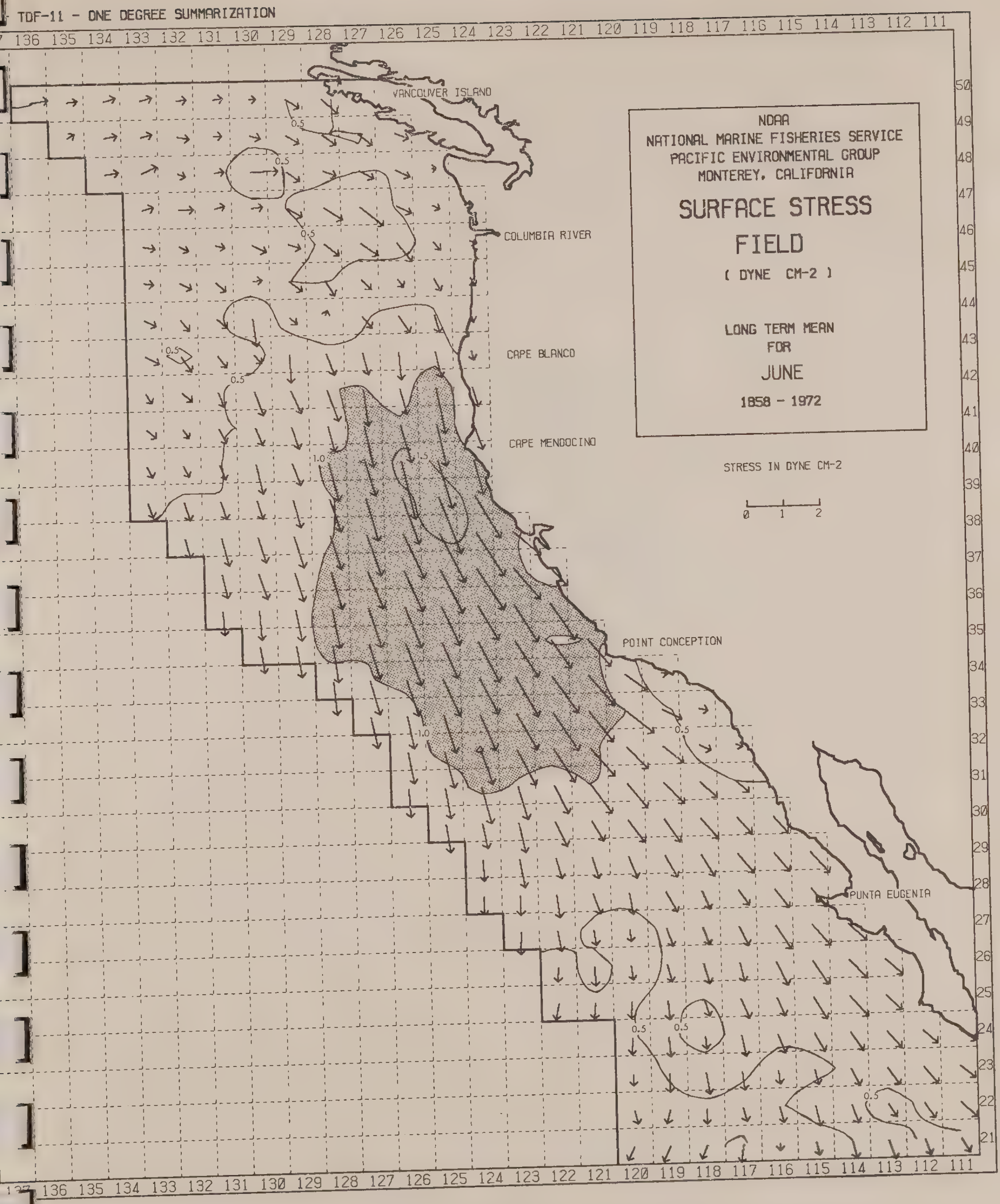
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.5
1.0
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
MAY
1857 - 1972
STRESS IN DYNE CM-2
0 1 2

Chart 5.—Resultant surface wind stress vectors for May.


TDF-11 - ONE DEGREE SUMMARIZATION
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50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
JUNE
1858 - 1972
STRESS IN DYNE CM-2
0 1 2
0.5
1.0
1.5
-1.0

Chart 6.—Resultant surface wind stress vectors for June.

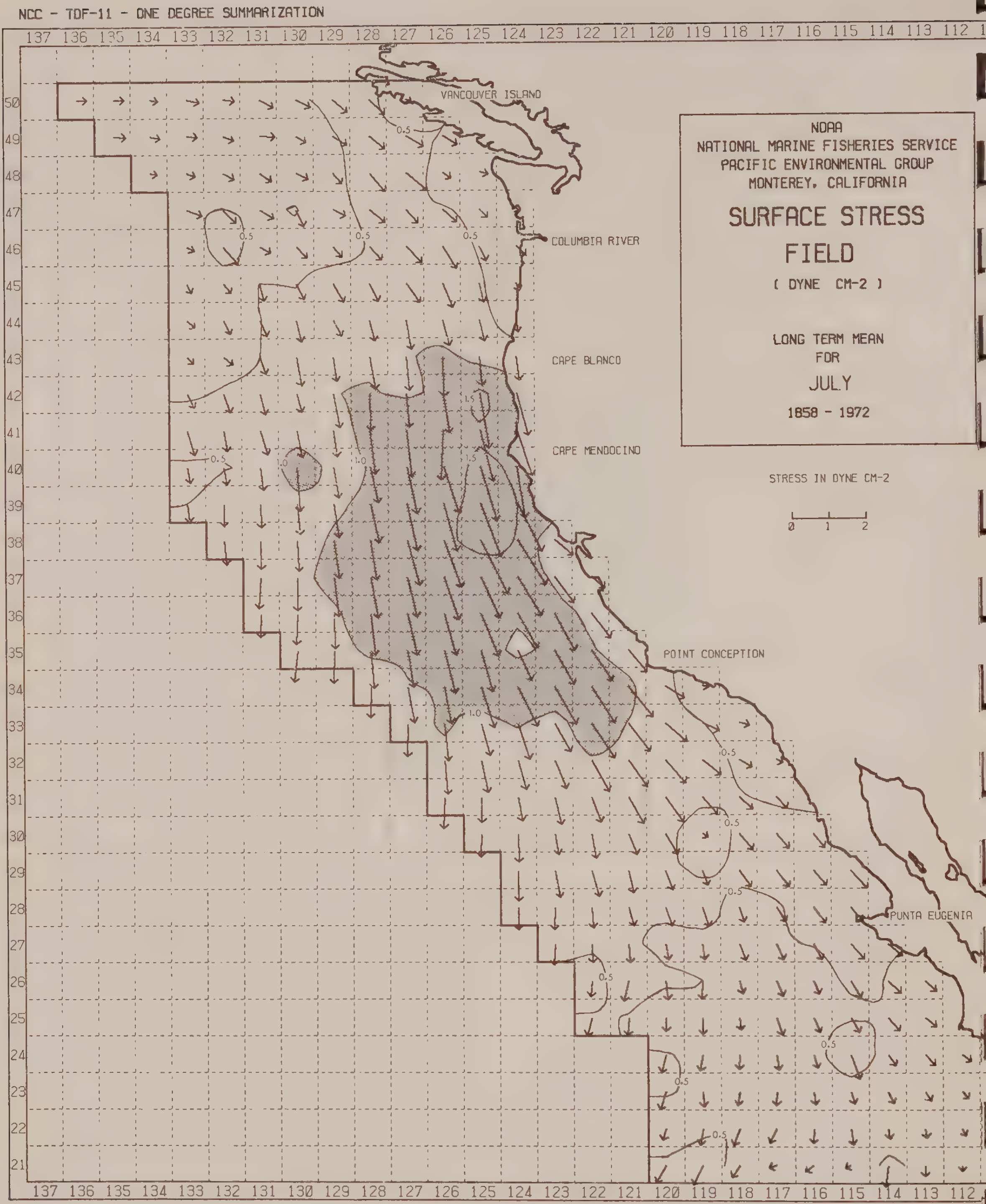

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
JULY
1858 - 1972
STRESS IN DYNE CM-2
0 1 2
0.5
1.0
1.5

Chart 7.—Resultant surface wind stress vectors for July.

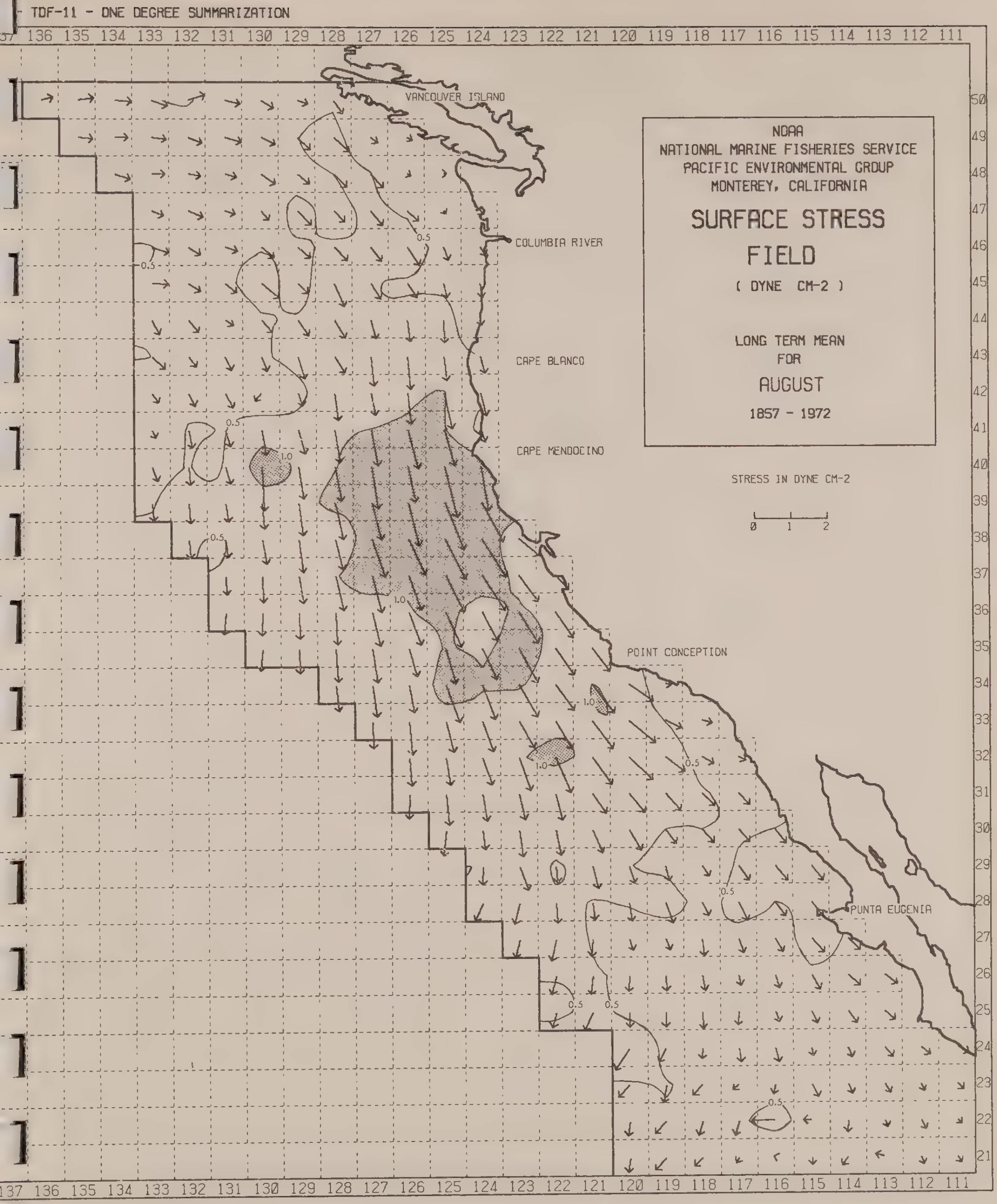

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
AUGUST
1857 - 1972
STRESS IN DYNE CM-2
0 1 2
0.5
1.0

Chart 8.—Resultant surface wind stress vectors for August.

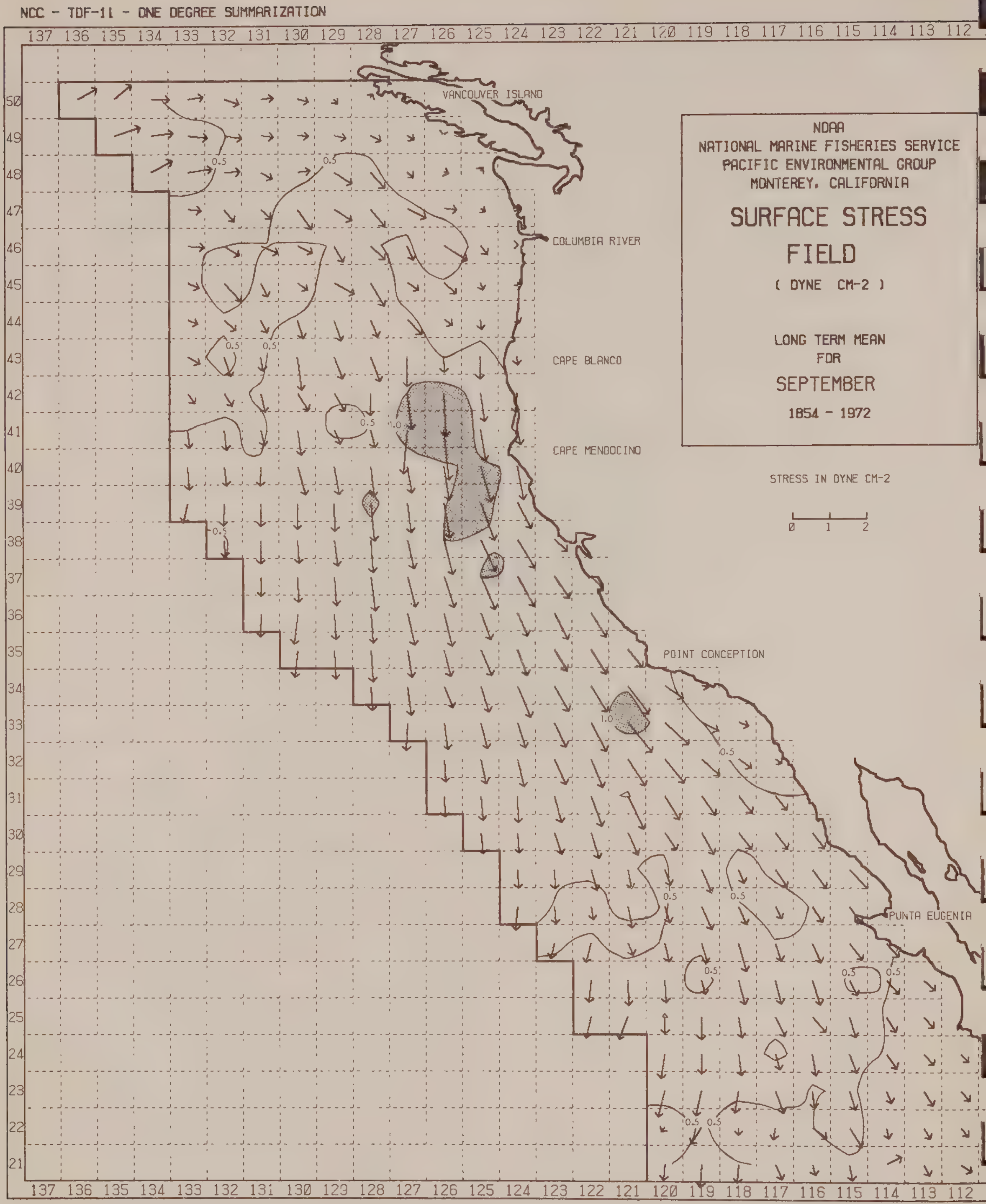

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.5
1.0
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS FIELD
(DYNE CM-2)
LONG TERM MEAN FOR SEPTEMBER
1854 - 1972
STRESS IN DYNE CM-2
0 1 2

Chart 9.—Resultant surface wind stress vectors for September.

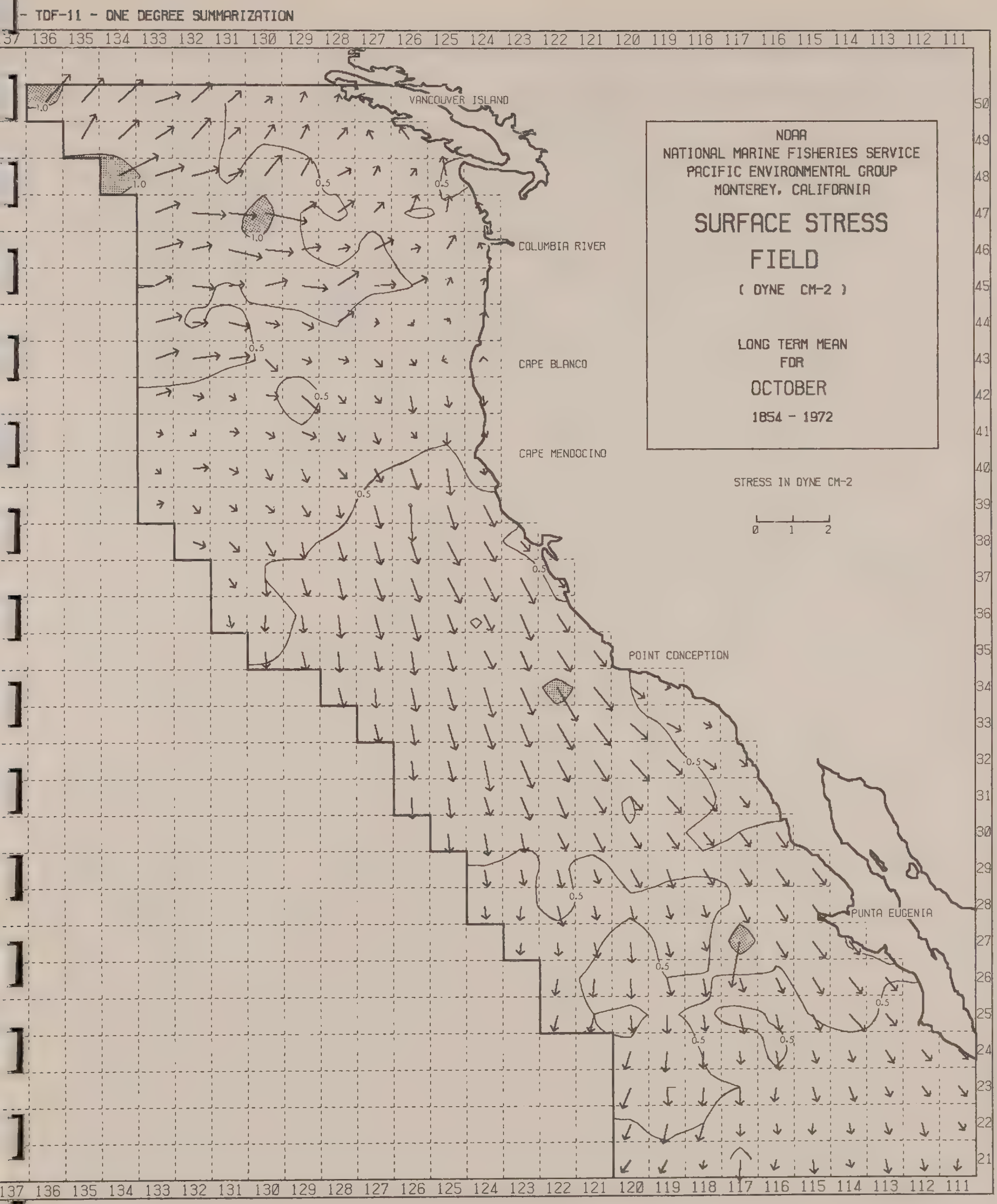
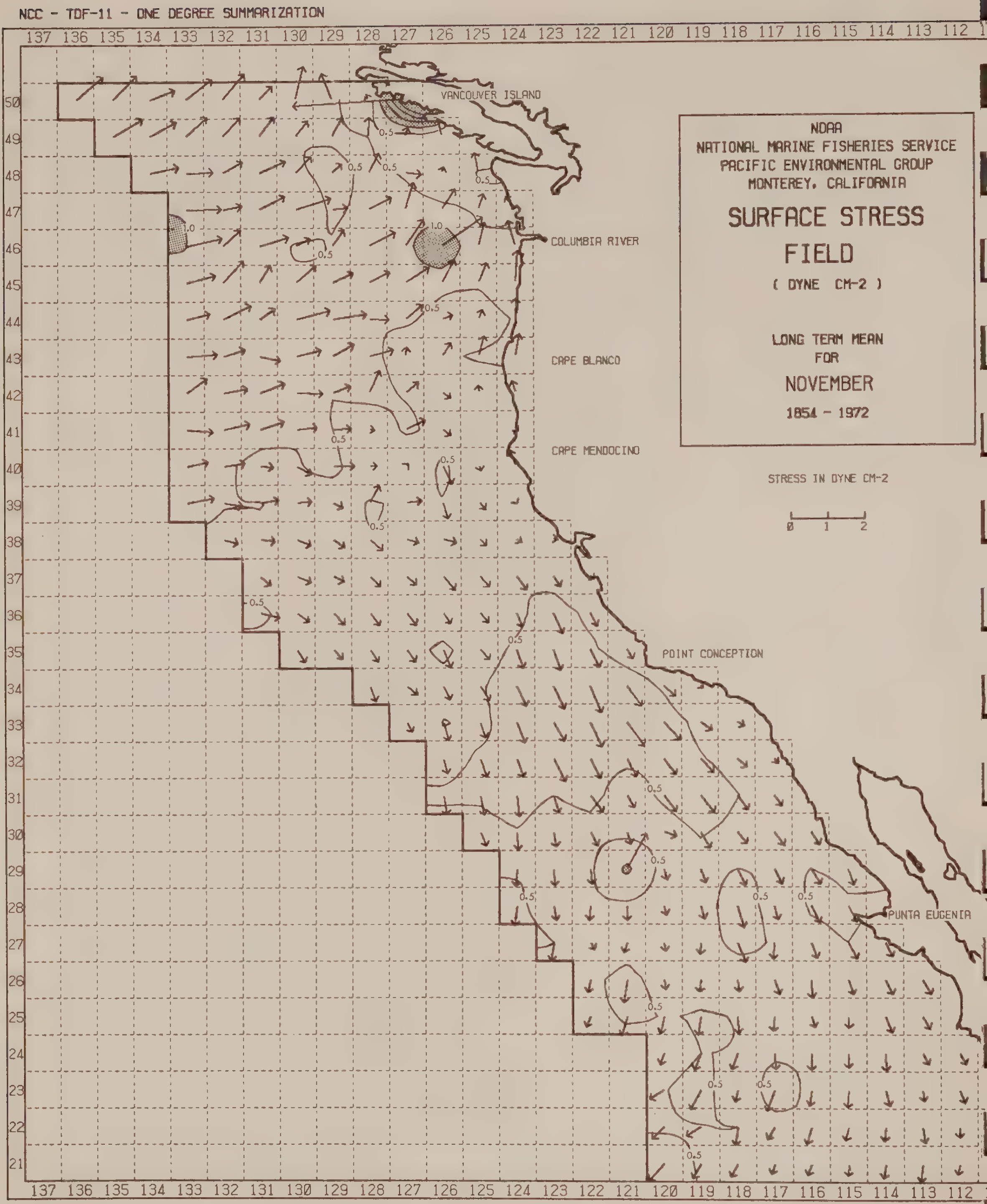

TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
OCTOBER
1854 - 1972
STRESS IN DYNE CM-2
0 1 2
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.5
1.0
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21

Chart 10.—Resultant surface wind stress vectors for October.


NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50
49
48
47
46
45
44
43
42
41
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21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
NOVEMBER
1854 - 1972
STRESS IN DYNE CM-2
0 1 2
0.5
1.0

Chart 11.—Resultant surface wind stress vectors for November.

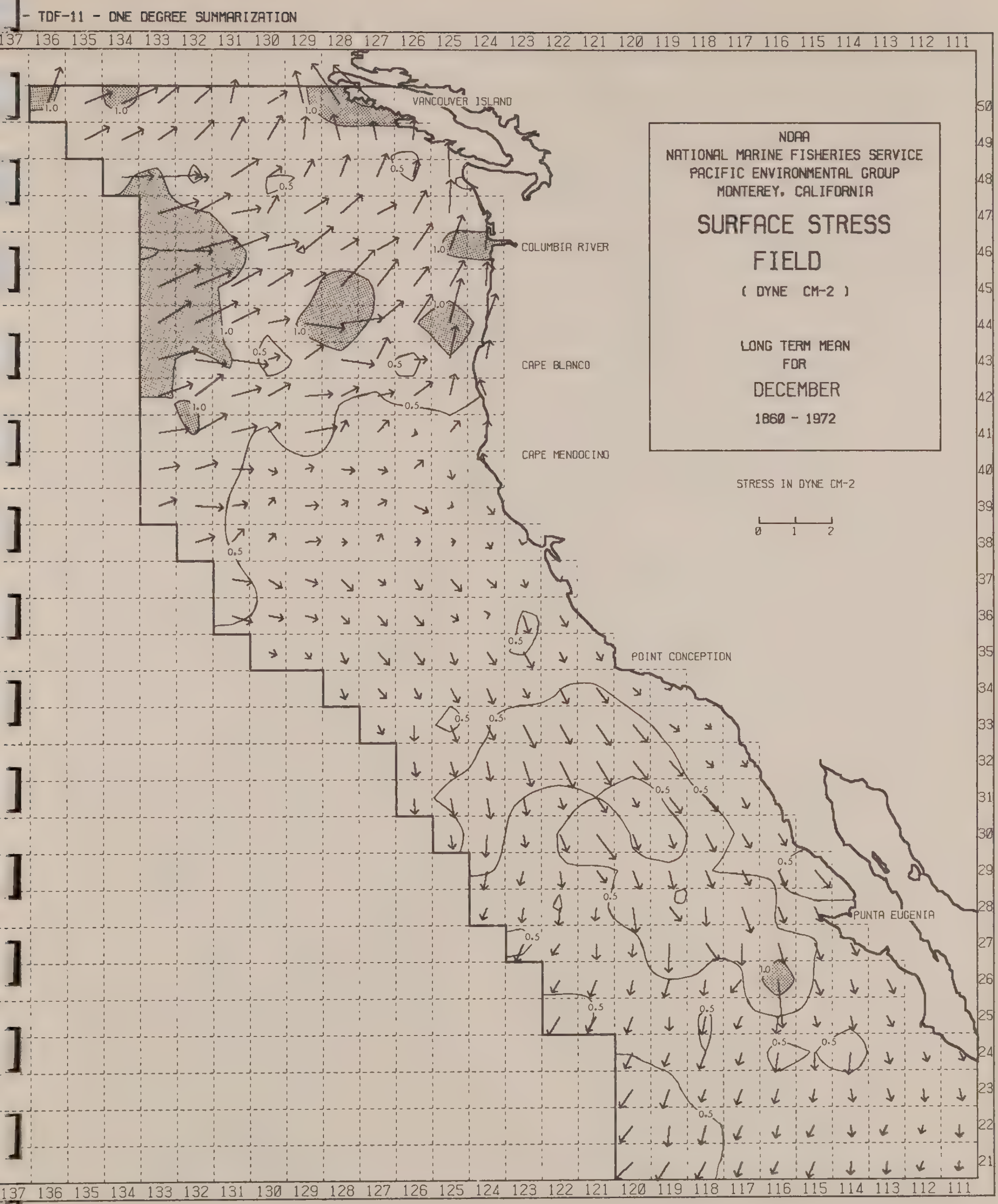

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
1.0
0.5
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
SURFACE STRESS
FIELD
(DYNE CM-2)
LONG TERM MEAN
FOR
DECEMBER
1860 - 1972
STRESS IN DYNE CM-2
0 1 2

Chart 12.—Resultant surface wind stress vectors for December.

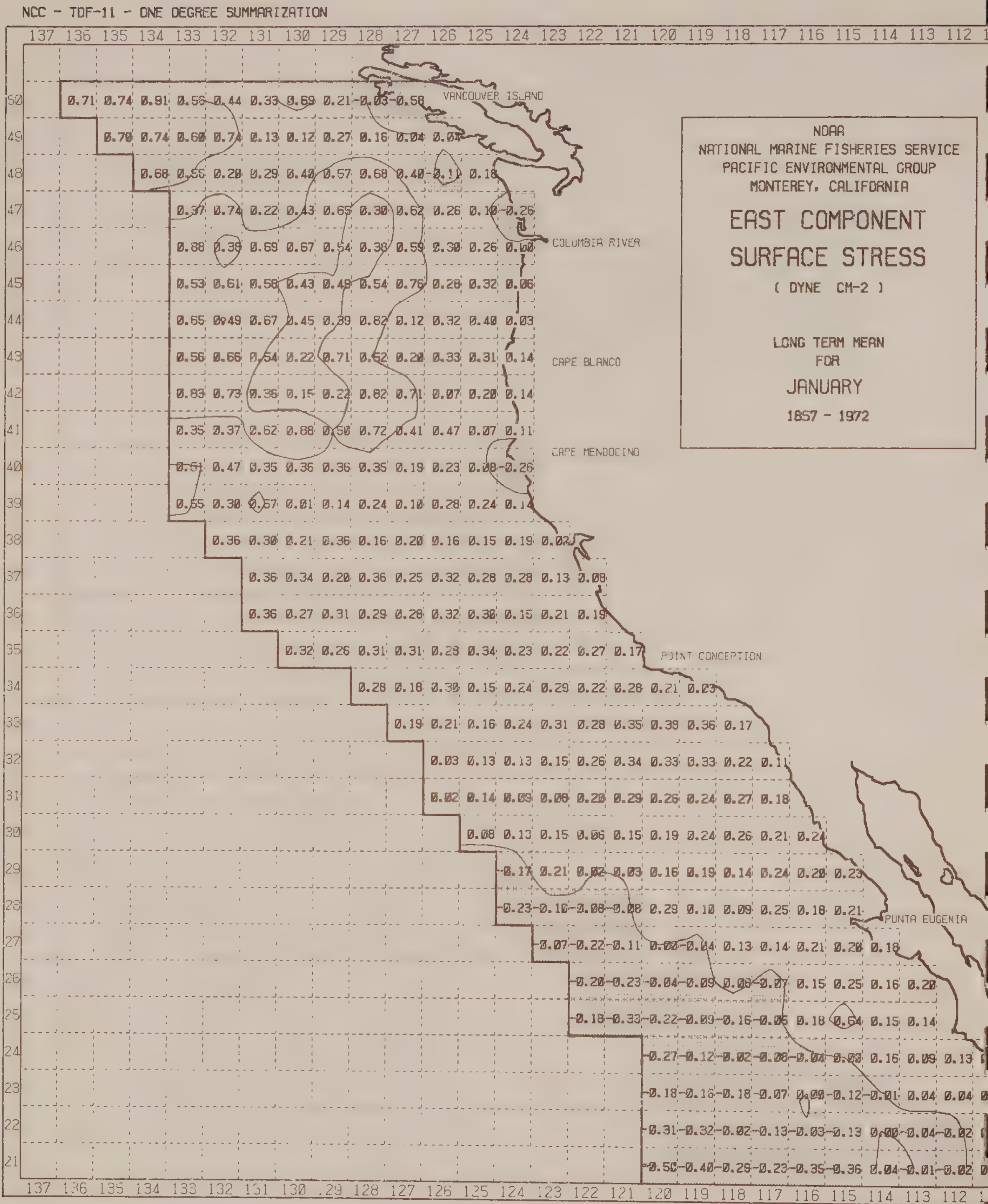

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JANUARY
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.71 0.74 0.91 0.56 0.44 0.33 0.69 0.21 -0.03 -0.58
0.70 0.74 0.60 0.74 0.13 0.12 0.27 0.16 0.04 0.07
0.68 0.55 0.20 0.29 0.42 0.57 0.68 0.40 -0.11 0.18
0.37 0.74 0.22 0.43 0.65 0.30 0.62 0.26 0.10 -0.26
0.88 0.38 0.69 0.67 0.54 0.38 0.59 0.30 0.26 0.00
0.53 0.61 0.58 0.43 0.49 0.54 0.76 0.28 0.32 0.06
0.65 0.49 0.67 0.45 0.39 0.82 0.12 0.32 0.40 0.03
0.56 0.66 0.54 0.22 0.71 0.52 0.20 0.33 0.31 0.14
0.83 0.73 0.36 0.15 0.22 0.82 0.71 0.07 0.20 0.14
0.35 0.37 0.62 0.88 0.50 0.72 0.41 0.47 0.07 0.11
0.51 0.47 0.35 0.36 0.36 0.35 0.19 0.23 0.08 -0.26
0.55 0.30 0.57 0.01 0.14 0.24 0.10 0.28 0.24 0.14
0.36 0.30 0.21 0.36 0.16 0.20 0.16 0.15 0.19 0.02
0.36 0.34 0.20 0.36 0.25 0.32 0.28 0.28 0.13 0.08
0.36 0.27 0.31 0.29 0.28 0.32 0.30 0.15 0.21 0.19
0.32 0.26 0.31 0.31 0.28 0.34 0.23 0.22 0.27 0.17
0.28 0.18 0.30 0.15 0.24 0.29 0.22 0.28 0.21 0.03
0.19 0.21 0.16 0.24 0.31 0.28 0.35 0.38 0.36 0.17
0.03 0.13 0.13 0.15 0.26 0.34 0.33 0.33 0.22 0.11
0.02 0.14 0.09 0.08 0.20 0.29 0.26 0.24 0.27 0.18
0.08 0.13 0.15 0.06 0.15 0.19 0.24 0.26 0.21 0.24
-0.17 0.21 0.02 0.03 0.16 0.19 0.14 0.24 0.20 0.23
-0.23 -0.10 -0.08 -0.08 0.29 0.10 0.09 0.25 0.18 0.21
-0.07 -0.22 -0.11 0.00 -0.04 0.13 0.14 0.21 0.20 0.18
-0.20 -0.23 -0.04 -0.09 0.08 -0.07 0.15 0.25 0.16 0.20
-0.18 -0.33 -0.22 -0.09 -0.16 -0.05 0.18 0.64 0.15 0.14
-0.27 -0.12 -0.02 -0.08 -0.04 0.03 0.16 0.09 0.13
-0.18 -0.16 -0.18 -0.07 0.00 -0.12 -0.01 0.04 0.04
-0.31 -0.32 -0.02 -0.13 -0.03 -0.13 0.00 -0.04 -0.02
-0.50 -0.40 -0.29 -0.23 -0.35 -0.36 0.04 -0.01 -0.02

Chart 13.—East component surface wind stress for January.

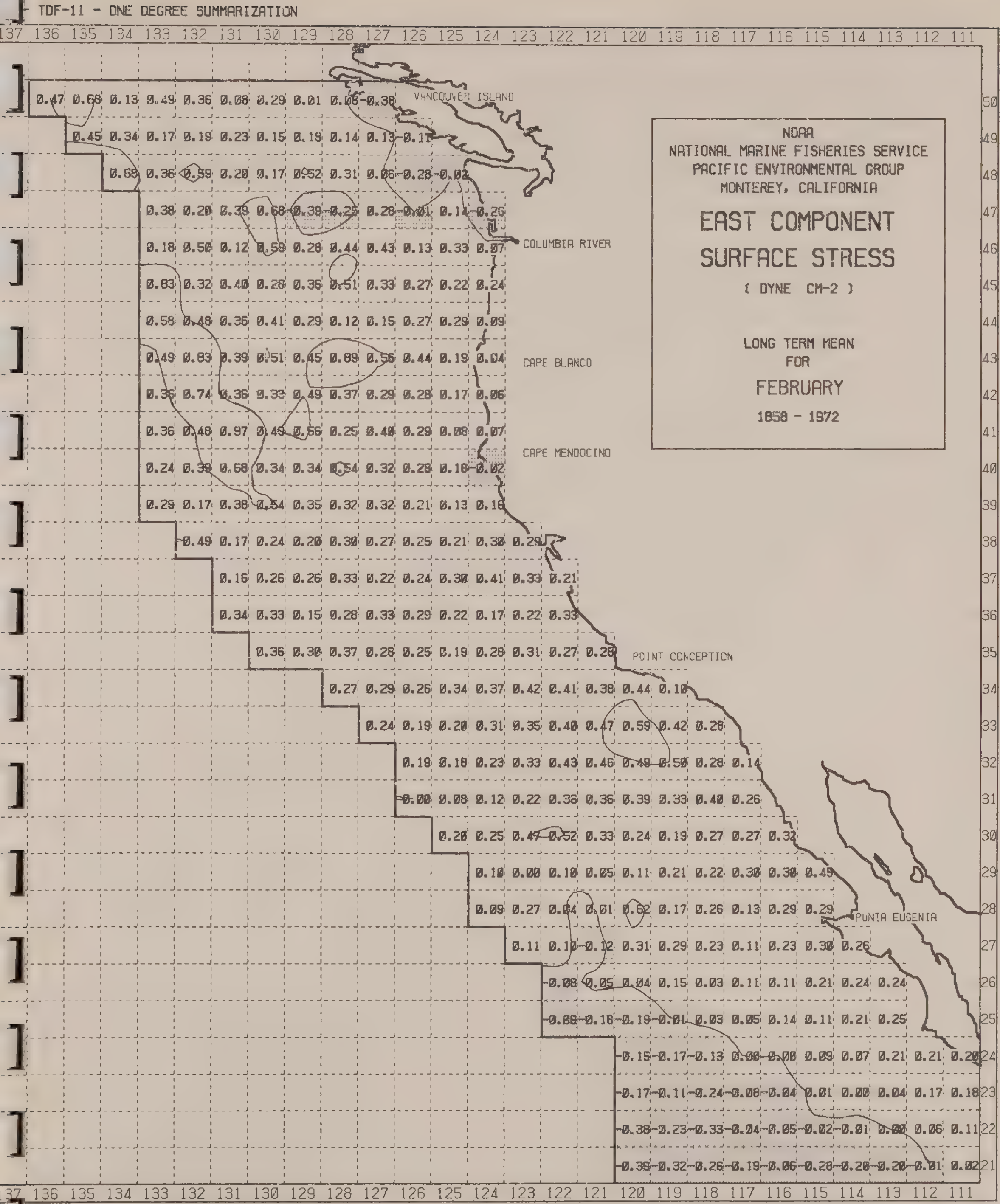

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
FEBRUARY
1858 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.47 0.68 0.13 0.49 0.36 0.08 0.29 0.01 0.08 -0.38
49 0.45 0.34 0.17 0.19 0.23 0.15 0.19 0.14 0.13 -0.11
48 0.68 0.36 0.59 0.20 0.17 0.52 0.31 0.06 -0.28 -0.02
47 0.38 0.20 0.39 0.68 -0.39 -0.25 0.28 -0.01 0.14 -0.26
46 0.18 0.50 0.12 0.59 0.28 0.44 0.43 0.13 0.33 0.07
45 0.83 0.32 0.40 0.28 0.36 0.51 0.33 0.27 0.22 0.24
44 0.58 0.48 0.36 0.41 0.29 0.12 0.15 0.27 0.29 0.09
43 0.49 0.83 0.39 0.51 0.45 0.89 0.56 0.44 0.19 0.04
42 0.35 0.74 0.36 0.33 0.49 0.37 0.29 0.28 0.17 0.06
41 0.36 0.48 0.97 0.49 0.56 0.25 0.40 0.29 0.08 0.07
40 0.24 0.39 0.68 0.34 0.34 0.54 0.32 0.28 0.18 -0.02
39 0.29 0.17 0.38 0.54 0.35 0.32 0.32 0.21 0.13 0.16
38 0.49 0.17 0.24 0.20 0.30 0.27 0.25 0.21 0.30 0.29
37 0.16 0.26 0.26 0.33 0.22 0.24 0.30 0.41 0.33 0.21
36 0.34 0.33 0.15 0.28 0.33 0.29 0.22 0.17 0.22 0.33
35 0.36 0.30 0.37 0.28 0.25 0.19 0.28 0.31 0.27 0.28
34 0.27 0.29 0.26 0.34 0.37 0.42 0.41 0.38 0.44 0.10
33 0.24 0.19 0.20 0.31 0.35 0.40 0.47 0.59 0.42 0.28
32 0.19 0.18 0.23 0.33 0.43 0.46 0.49 0.50 0.28 0.14
31 0.00 0.08 0.12 0.22 0.36 0.36 0.39 0.33 0.40 0.26
30 0.20 0.25 0.47 0.52 0.33 0.24 0.19 0.27 0.27 0.32
29 0.10 0.00 0.10 0.05 0.11 0.21 0.22 0.30 0.30 0.49
28 0.09 0.27 0.04 0.01 0.62 0.17 0.26 0.13 0.29 0.29
27 0.11 0.10 -0.12 0.31 0.29 0.23 0.11 0.23 0.30 0.26
26 -0.08 0.05 0.04 0.15 0.03 0.11 0.11 0.21 0.24 0.24
25 -0.09 -0.18 -0.19 -0.01 0.03 0.05 0.14 0.11 0.21 0.25
24 -0.15 -0.17 -0.13 0.00 -0.00 0.09 0.07 0.21 0.21 0.20
23 -0.17 -0.11 -0.24 -0.08 -0.04 0.01 0.00 0.04 0.17 0.18
22 -0.38 -0.23 -0.33 -0.04 -0.05 -0.02 -0.01 0.00 0.06 0.11
21 -0.39 -0.32 -0.26 -0.19 -0.06 -0.28 -0.20 -0.20 -0.01 0.02
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 14.—East component surface wind stress for February.

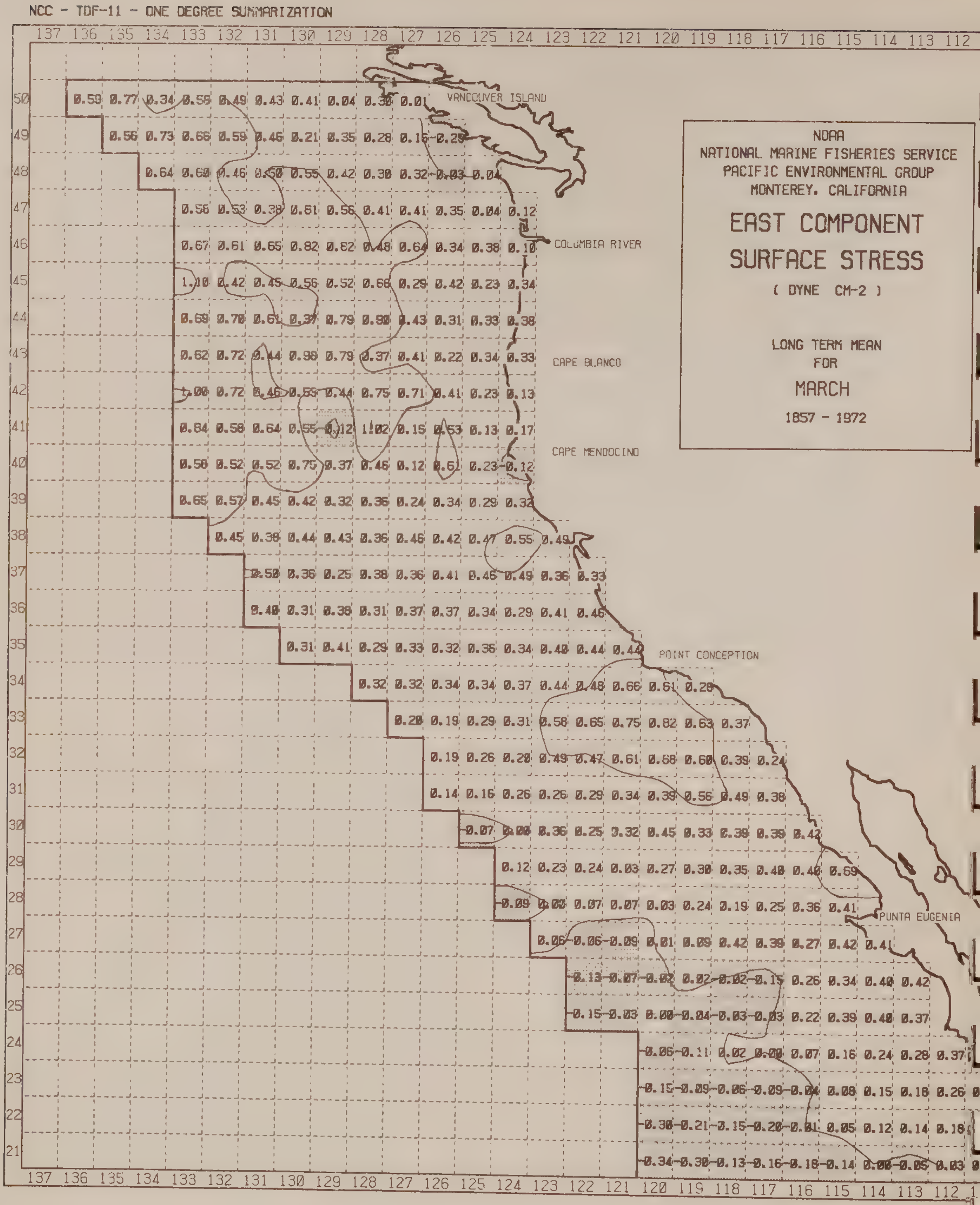

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
MARCH
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA

Chart 15.—East component surface wind stress for March.

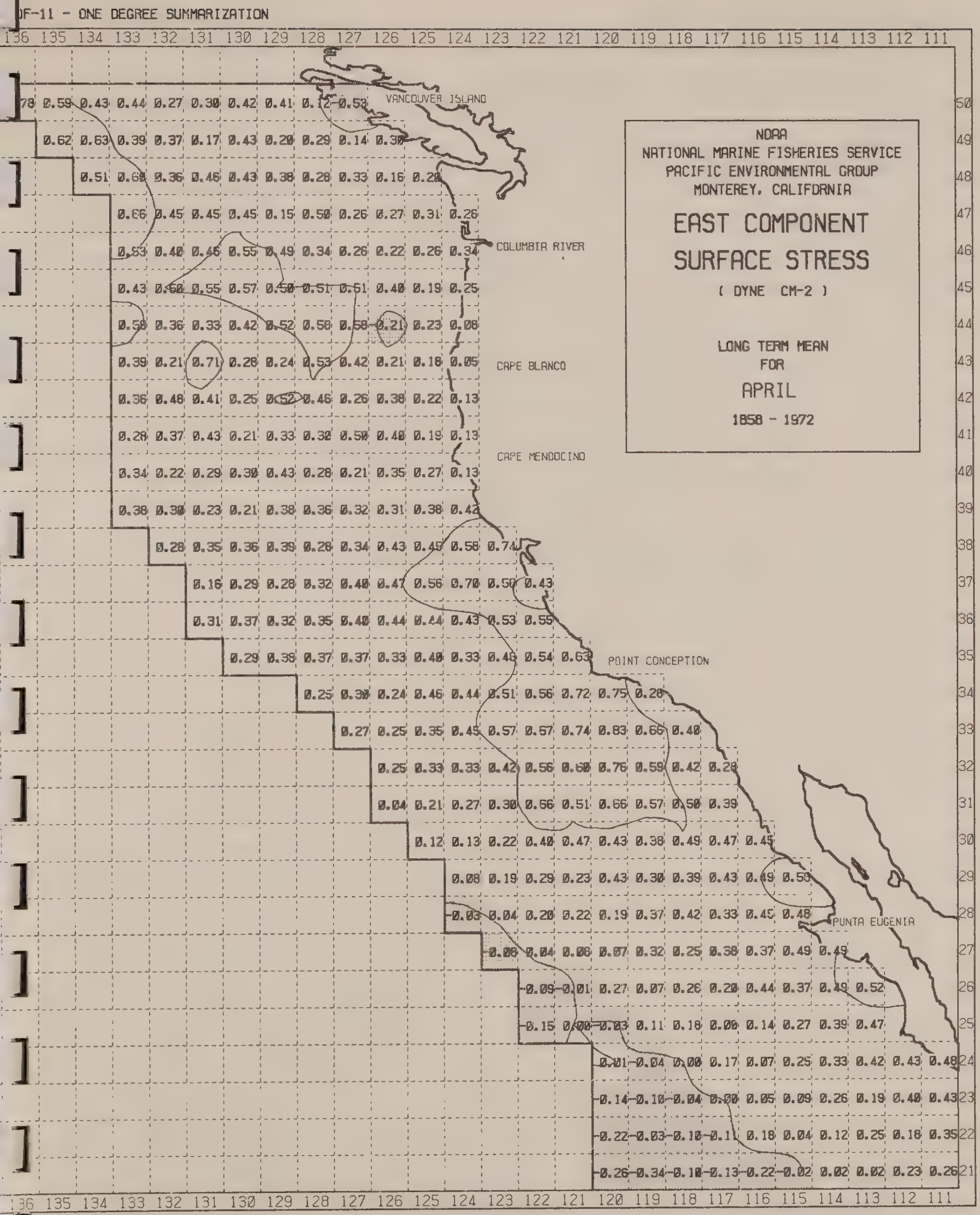
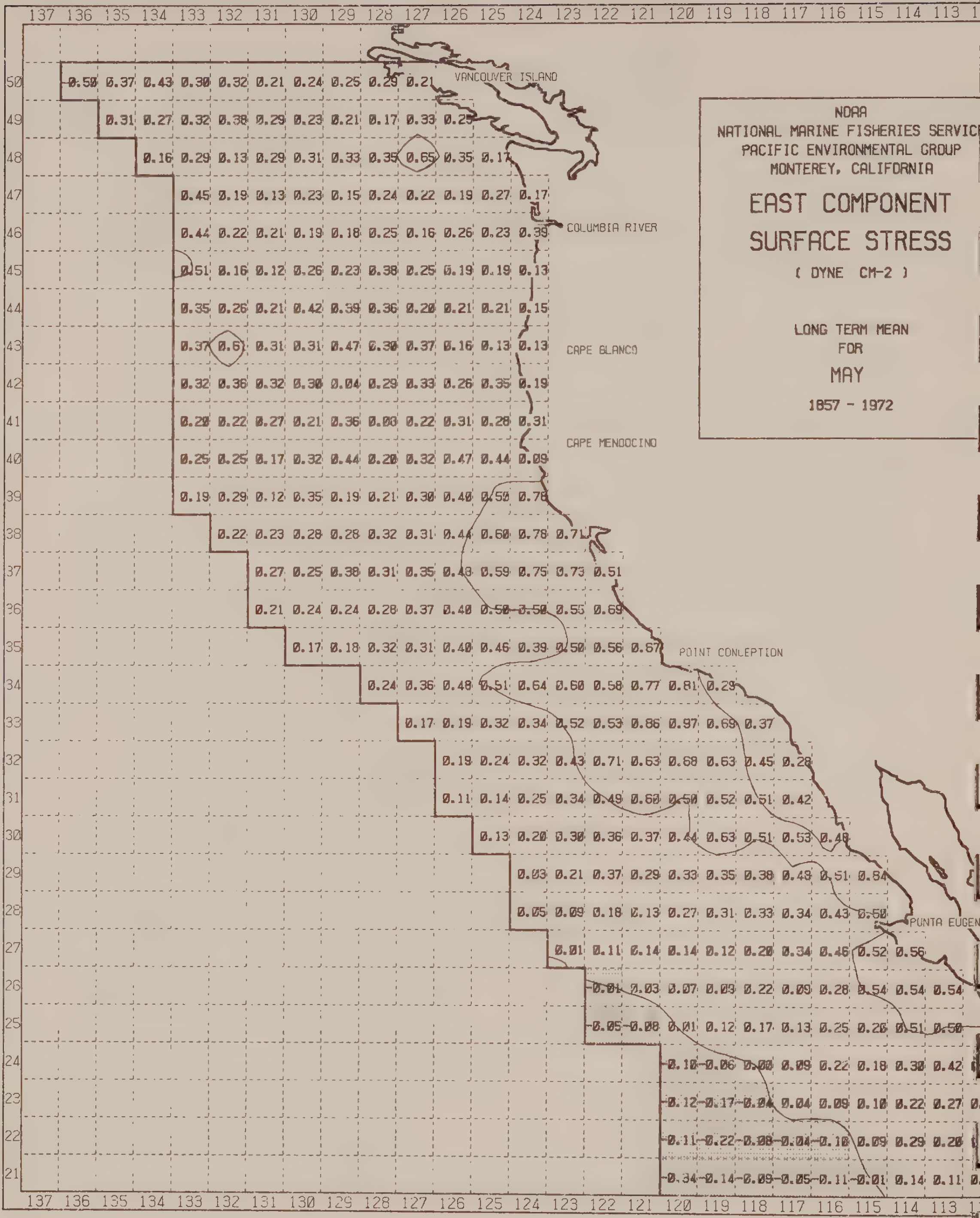

F-11 - ONE DEGREE SUMMARIZATION
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
APRIL
1850 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50: 78 0.59 0.43 0.44 0.27 0.30 0.42 0.41 0.12 0.53
49: 0.62 0.63 0.39 0.37 0.17 0.43 0.20 0.29 0.14 0.30
48: 0.51 0.60 0.36 0.46 0.43 0.38 0.28 0.33 0.16 0.20
47: 0.66 0.45 0.45 0.45 0.15 0.50 0.26 0.27 0.31 0.26
46: 0.53 0.40 0.46 0.55 0.49 0.34 0.26 0.22 0.26 0.34
45: 0.43 0.60 0.55 0.57 0.50 0.51 0.51 0.40 0.19 0.25
44: 0.58 0.36 0.33 0.42 0.52 0.58 0.58 0.21 0.23 0.08
43: 0.39 0.21 0.71 0.28 0.24 0.53 0.42 0.21 0.18 0.05
42: 0.36 0.48 0.41 0.25 0.52 0.46 0.26 0.38 0.22 0.13
41: 0.28 0.37 0.43 0.21 0.33 0.32 0.50 0.40 0.19 0.13
40: 0.34 0.22 0.29 0.30 0.43 0.28 0.21 0.35 0.27 0.13
39: 0.38 0.30 0.23 0.21 0.38 0.36 0.32 0.31 0.38 0.42
38: 0.28 0.35 0.36 0.39 0.28 0.34 0.43 0.45 0.58 0.74
37: 0.16 0.29 0.28 0.32 0.40 0.47 0.56 0.70 0.50 0.43
36: 0.31 0.37 0.32 0.35 0.40 0.44 0.44 0.43 0.53 0.55
35: 0.29 0.38 0.37 0.37 0.33 0.40 0.33 0.46 0.54 0.63
34: 0.25 0.30 0.24 0.46 0.44 0.51 0.56 0.72 0.75 0.28
33: 0.27 0.25 0.35 0.45 0.57 0.57 0.74 0.83 0.66 0.40
32: 0.25 0.33 0.33 0.42 0.56 0.60 0.76 0.59 0.42 0.28
31: 0.04 0.21 0.27 0.30 0.66 0.51 0.66 0.57 0.50 0.39
30: 0.12 0.13 0.22 0.40 0.47 0.43 0.38 0.49 0.47 0.45
29: 0.08 0.19 0.29 0.23 0.43 0.30 0.39 0.43 0.49 0.50
28: -0.03 0.04 0.20 0.22 0.19 0.37 0.42 0.33 0.45 0.48
27: -0.08 0.04 0.08 0.07 0.32 0.25 0.38 0.37 0.49 0.49
26: -0.09 -0.01 0.27 0.07 0.26 0.20 0.44 0.37 0.49 0.52
25: -0.15 0.00 -0.03 0.11 0.18 0.00 0.14 0.27 0.39 0.47
24: 0.01 -0.04 0.00 0.17 0.07 0.25 0.33 0.42 0.43 0.48
23: -0.14 -0.10 -0.04 0.00 0.05 0.09 0.26 0.19 0.40 0.43
22: -0.22 -0.03 -0.10 -0.11 0.18 0.04 0.12 0.25 0.18 0.35
21: -0.26 -0.34 -0.10 -0.13 -0.22 -0.02 0.02 0.02 0.23 0.26
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 16.—East component surface wind stress for April.

NCC - TDF-11 - ONE DEGREE SUMMARIZATION



NOAA
NATIONAL MARINE FISHERIES SERVIC
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA

EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)

LONG TERM MEAN
FOR
MAY
1857 - 1972

	137	136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113
50		0.50	0.37	0.43	0.30	0.32	0.21	0.24	0.25	0.29	0.21														
49			0.31	0.27	0.32	0.30	0.29	0.23	0.21	0.17	0.33	0.25													
48				0.16	0.29	0.13	0.29	0.31	0.33	0.35	0.65	0.35	0.17												
47					0.45	0.19	0.13	0.23	0.15	0.24	0.22	0.19	0.27	0.17											
46					0.44	0.22	0.21	0.19	0.18	0.25	0.16	0.26	0.23	0.39											
45					0.51	0.16	0.12	0.26	0.23	0.38	0.25	0.19	0.19	0.13											
44					0.35	0.26	0.21	0.42	0.39	0.36	0.20	0.21	0.21	0.15											
43					0.37	0.6	0.31	0.31	0.47	0.30	0.37	0.16	0.13	0.13											
42					0.32	0.36	0.32	0.30	0.04	0.29	0.33	0.26	0.35	0.19											
41					0.20	0.22	0.27	0.21	0.36	0.00	0.22	0.31	0.28	0.31											
40					0.25	0.25	0.17	0.32	0.44	0.20	0.32	0.47	0.44	0.09											
39					0.19	0.29	0.12	0.35	0.19	0.21	0.30	0.40	0.50	0.78											
38						0.22	0.23	0.28	0.28	0.32	0.31	0.44	0.60	0.78	0.71										
37							0.27	0.25	0.38	0.31	0.35	0.48	0.59	0.75	0.73	0.51									
36							0.21	0.24	0.24	0.28	0.37	0.40	0.50	0.50	0.55	0.69									
35								0.17	0.18	0.32	0.31	0.40	0.46	0.39	0.50	0.56	0.67								
34										0.24	0.36	0.48	0.51	0.64	0.60	0.58	0.77	0.81	0.29						
33											0.17	0.19	0.32	0.34	0.52	0.53	0.86	0.97	0.69	0.37					
32												0.19	0.24	0.32	0.43	0.71	0.63	0.68	0.63	0.45	0.28				
31												0.11	0.14	0.25	0.34	0.49	0.60	0.50	0.52	0.51	0.42				
30													0.13	0.20	0.30	0.36	0.37	0.44	0.63	0.51	0.53	0.48			
29														0.03	0.21	0.37	0.29	0.33	0.35	0.38	0.48	0.51	0.84		
28														0.05	0.09	0.18	0.13	0.27	0.31	0.33	0.34	0.43	0.50		
27															0.01	0.11	0.14	0.14	0.12	0.20	0.34	0.46	0.52	0.56	
26																-0.01	0.03	0.07	0.03	0.22	0.09	0.28	0.54	0.54	0.54
25																-0.05	-0.08	0.01	0.12	0.17	0.13	0.25	0.26	0.51	0.50
24																		-0.10	-0.06	0.00	0.09	0.22	0.18	0.30	0.42
23																		-0.12	-0.17	-0.04	0.04	0.09	0.10	0.22	0.27
22																		-0.11	-0.22	-0.08	-0.04	-0.10	0.09	0.29	0.20
21																		-0.34	-0.14	-0.09	-0.05	-0.11	-0.01	0.14	0.11

Chart 17.—East component surface wind stress for May.

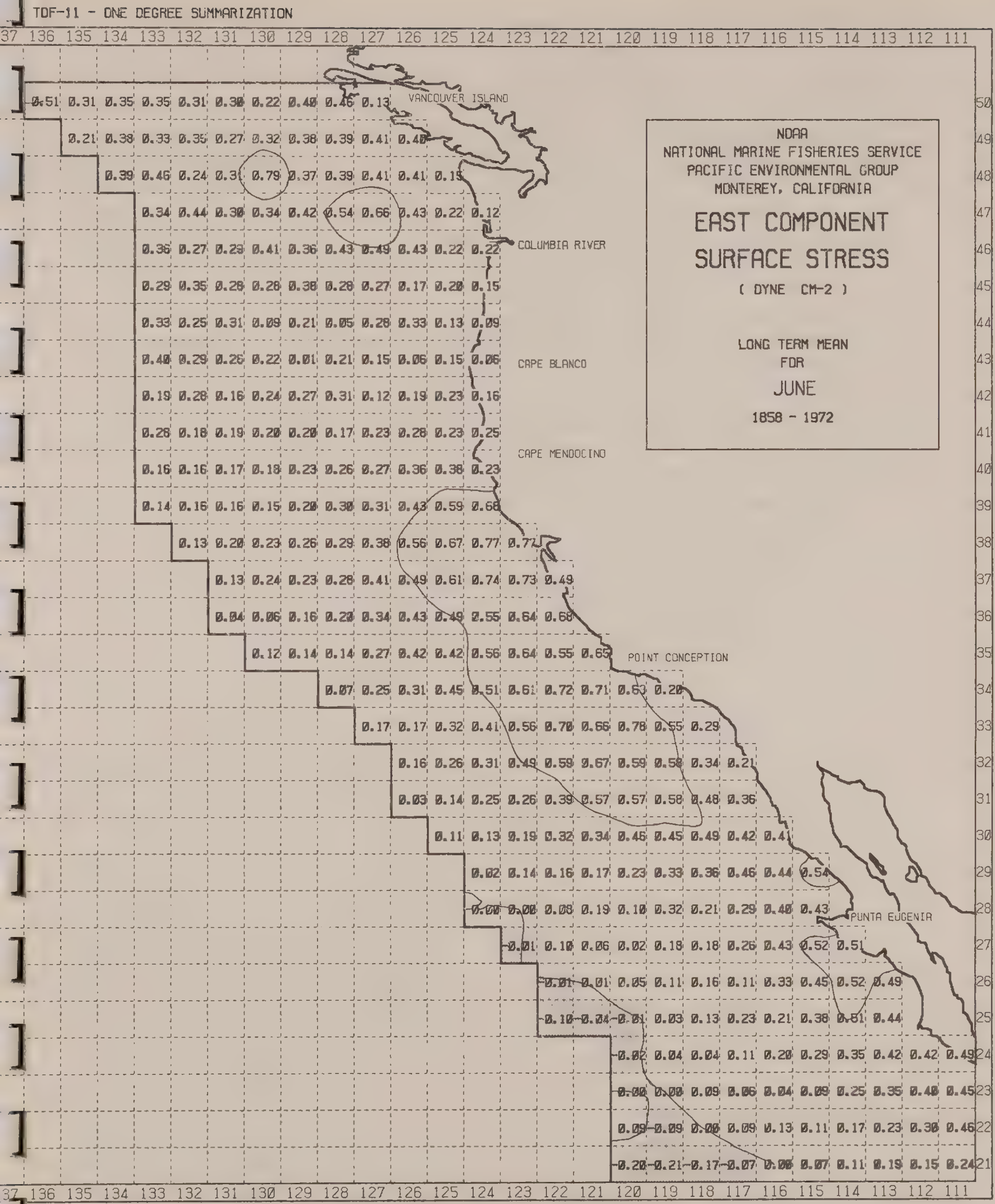
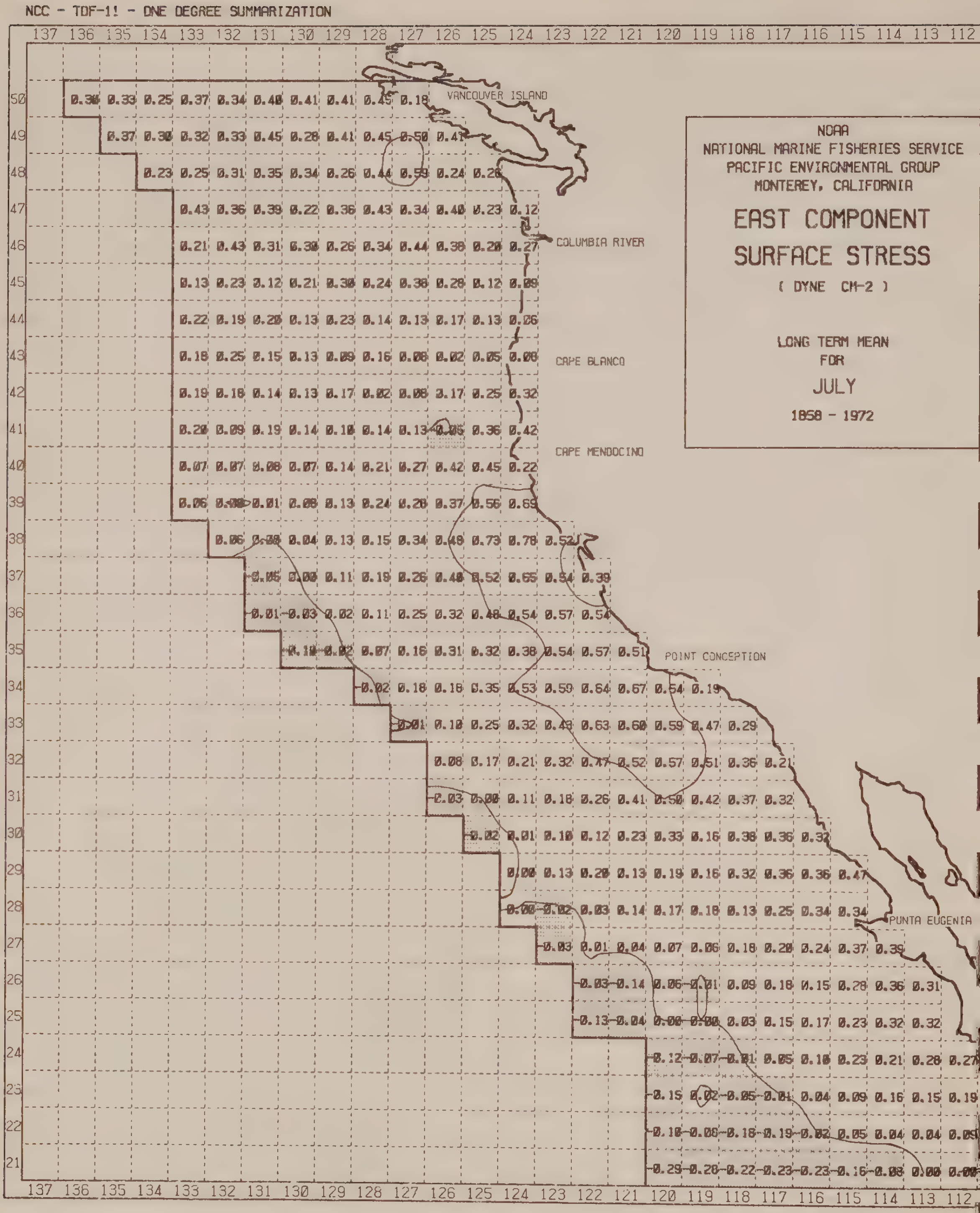

TDF-11 - ONE DEGREE SUMMARIZATION
37 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JUNE
1858 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.51 0.31 0.35 0.35 0.31 0.30 0.22 0.40 0.46 0.13
49 0.21 0.38 0.33 0.35 0.27 0.32 0.38 0.39 0.41 0.40
48 0.39 0.46 0.24 0.31 0.79 0.37 0.39 0.41 0.41 0.15
47 0.34 0.44 0.30 0.34 0.42 0.54 0.66 0.43 0.22 0.12
46 0.36 0.27 0.29 0.41 0.36 0.43 0.49 0.43 0.22 0.22
45 0.29 0.35 0.28 0.28 0.30 0.28 0.27 0.17 0.20 0.15
44 0.33 0.25 0.31 0.09 0.21 0.05 0.28 0.33 0.13 0.09
43 0.40 0.29 0.26 0.22 0.01 0.21 0.15 0.06 0.15 0.06
42 0.19 0.28 0.16 0.24 0.27 0.31 0.12 0.19 0.23 0.16
41 0.28 0.18 0.19 0.20 0.20 0.17 0.23 0.28 0.23 0.25
40 0.16 0.16 0.17 0.18 0.23 0.26 0.27 0.36 0.38 0.23
39 0.14 0.16 0.16 0.15 0.20 0.30 0.31 0.43 0.59 0.68
38 0.13 0.20 0.23 0.26 0.29 0.38 0.56 0.67 0.77 0.77
37 0.13 0.24 0.23 0.28 0.41 0.49 0.61 0.74 0.73 0.49
36 0.04 0.06 0.16 0.23 0.34 0.43 0.49 0.55 0.64 0.68
35 0.12 0.14 0.14 0.27 0.42 0.42 0.56 0.64 0.55 0.65
34 0.07 0.25 0.31 0.45 0.51 0.61 0.72 0.71 0.63 0.20
33 0.17 0.17 0.32 0.41 0.56 0.70 0.66 0.78 0.55 0.29
32 0.16 0.26 0.31 0.49 0.59 0.67 0.59 0.58 0.34 0.21
31 0.03 0.14 0.25 0.26 0.39 0.57 0.57 0.58 0.48 0.36
30 0.11 0.13 0.19 0.32 0.34 0.46 0.45 0.49 0.42 0.41
29 0.02 0.14 0.16 0.17 0.23 0.33 0.36 0.46 0.44 0.54
28 -0.00 0.00 0.08 0.19 0.10 0.32 0.21 0.29 0.40 0.43
27 -0.01 0.10 0.06 0.02 0.18 0.18 0.26 0.43 0.52 0.51
26 -0.01 0.01 0.05 0.11 0.16 0.11 0.33 0.45 0.52 0.49
25 -0.10 -0.04 -0.01 0.03 0.13 0.23 0.21 0.38 0.81 0.44
24 -0.02 0.04 0.04 0.11 0.20 0.29 0.35 0.42 0.42 0.49
23 -0.00 0.00 0.09 0.06 0.04 0.09 0.25 0.35 0.40 0.45
22 0.09 -0.09 0.00 0.09 0.13 0.11 0.17 0.23 0.30 0.46
21 -0.20 -0.21 -0.17 -0.07 0.00 0.07 0.11 0.19 0.15 0.24
37 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 18.—East component surface wind stress for June.


NCC - TDF-1! - ONE DEGREE SUMMARIZATION
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JULY
1858 - 1972

	137	136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112
50		0.30	0.33	0.25	0.37	0.34	0.40	0.41	0.41	0.45	0.18															
49			0.37	0.30	0.32	0.33	0.45	0.28	0.41	0.45	0.50	0.47														
48				0.23	0.25	0.31	0.35	0.34	0.26	0.44	0.59	0.24	0.26													
47					0.43	0.36	0.39	0.22	0.36	0.43	0.34	0.40	0.23	0.12												
46					0.21	0.43	0.31	0.30	0.26	0.34	0.44	0.38	0.20	0.27												
45					0.13	0.23	0.12	0.21	0.30	0.24	0.38	0.28	0.12	0.09												
44					0.22	0.19	0.20	0.13	0.23	0.14	0.13	0.17	0.13	0.06												
43					0.18	0.25	0.15	0.13	0.09	0.16	0.08	0.02	0.05	0.08												
42					0.19	0.18	0.14	0.13	0.17	0.02	0.08	0.17	0.25	0.32												
41					0.20	0.09	0.19	0.14	0.10	0.14	0.13	0.05	0.36	0.42												
40					0.07	0.07	0.08	0.07	0.14	0.21	0.27	0.42	0.45	0.22												
39					0.06	0.00	-0.01	0.08	0.13	0.24	0.20	0.37	0.56	0.69												
38						0.06	0.08	0.04	0.13	0.15	0.34	0.48	0.73	0.78	0.52											
37							-0.05	0.00	0.11	0.19	0.26	0.40	0.52	0.65	0.54	0.39										
36							-0.01	-0.03	0.02	0.11	0.25	0.32	0.48	0.54	0.57	0.54										
35								-0.10	-0.02	0.07	0.16	0.31	0.32	0.38	0.54	0.57	0.51									
34										-0.02	0.18	0.16	0.35	0.53	0.59	0.64	0.67	0.54	0.19							
33											-0.01	0.10	0.25	0.32	0.43	0.63	0.60	0.59	0.47	0.29						
32												0.08	0.17	0.21	0.32	0.47	0.52	0.57	0.51	0.36	0.21					
31												-0.03	0.00	0.11	0.18	0.26	0.41	0.50	0.42	0.37	0.32					
30													-0.02	0.01	0.10	0.12	0.23	0.33	0.16	0.38	0.36	0.32				
29														0.00	0.13	0.20	0.13	0.19	0.16	0.32	0.36	0.36	0.47			
28														-0.00	-0.02	0.03	0.14	0.17	0.18	0.13	0.25	0.34	0.34			
27															-0.03	0.01	0.04	0.07	0.06	0.18	0.20	0.24	0.37	0.39		
26																-0.03	-0.14	0.06	-0.01	0.09	0.18	0.15	0.28	0.36	0.31	
25																-0.13	-0.04	0.00	-0.00	0.03	0.15	0.17	0.23	0.32	0.32	
24																		-0.12	-0.07	-0.01	0.05	0.10	0.23	0.21	0.28	0.27
23																		-0.15	0.02	-0.05	-0.01	0.04	0.09	0.16	0.15	0.19
22																		-0.10	-0.08	-0.18	-0.19	-0.02	0.05	0.04	0.04	0.09
21																		-0.29	-0.20	-0.22	-0.23	-0.23	-0.16	-0.08	0.00	0.00

Chart 19.—East component surface wind stress for July.

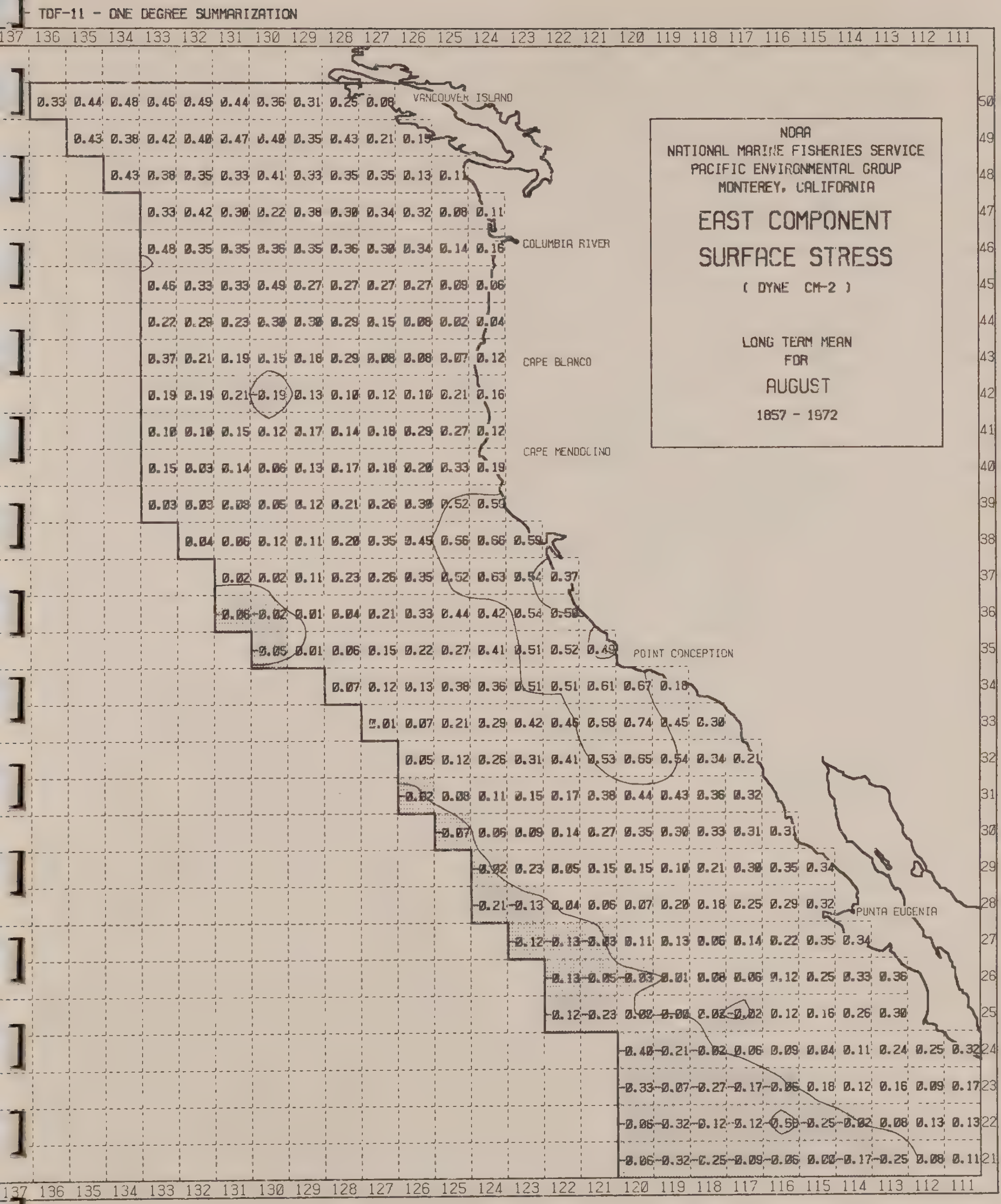
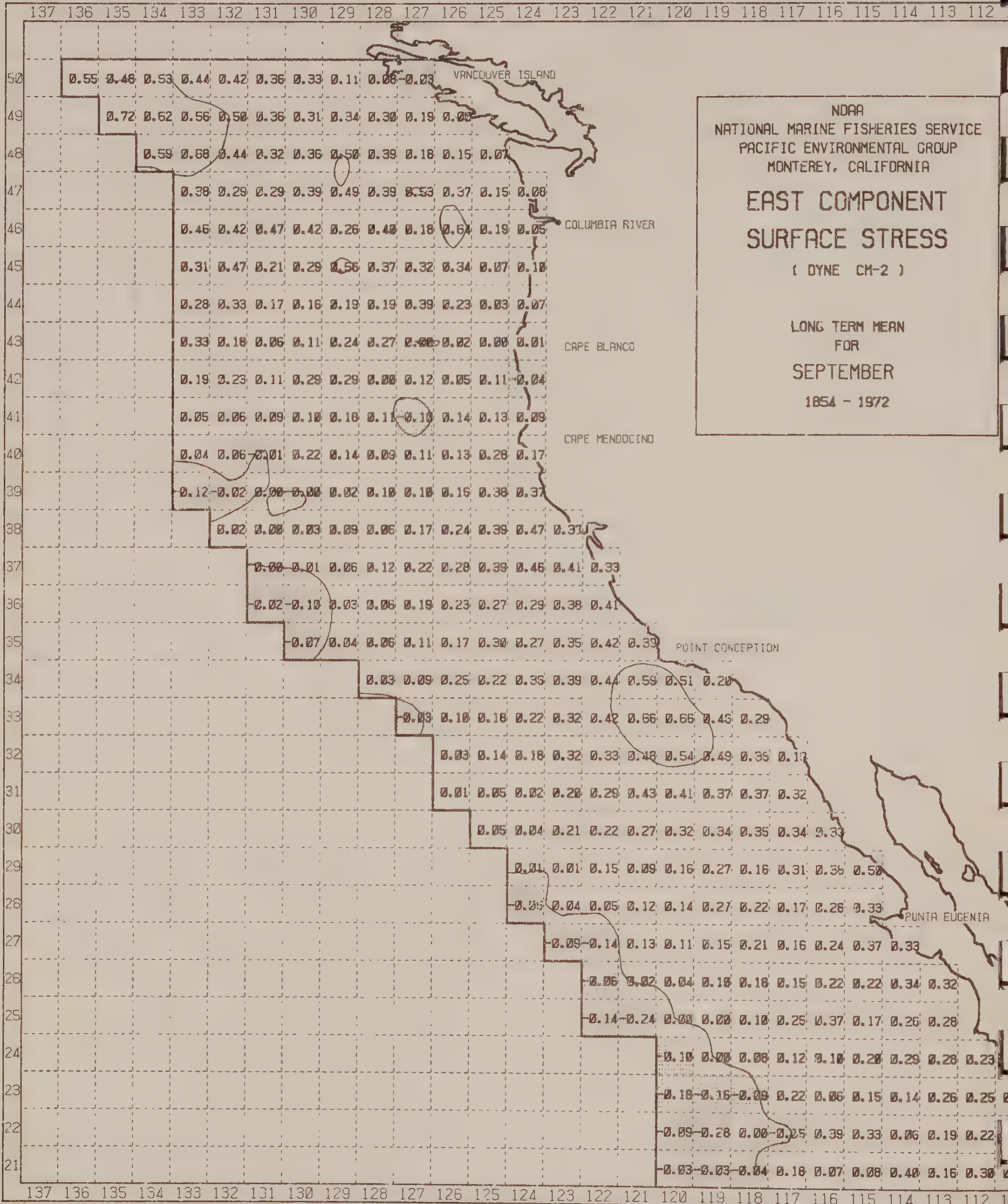

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
AUGUST
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.33 0.44 0.48 0.46 0.49 0.44 0.36 0.31 0.25 0.08
0.43 0.38 0.42 0.40 0.47 0.40 0.35 0.43 0.21 0.15
0.43 0.38 0.35 0.33 0.41 0.33 0.35 0.35 0.13 0.11
0.33 0.42 0.30 0.22 0.38 0.30 0.34 0.32 0.08 0.11
0.48 0.35 0.35 0.36 0.35 0.36 0.30 0.34 0.14 0.16
0.46 0.33 0.33 0.49 0.27 0.27 0.27 0.27 0.09 0.06
0.22 0.29 0.23 0.30 0.30 0.29 0.15 0.08 0.02 0.04
0.37 0.21 0.19 0.15 0.16 0.29 0.08 0.08 0.07 0.12
0.19 0.19 0.21 -0.19 0.13 0.10 0.12 0.10 0.21 0.16
0.10 0.10 0.15 0.12 0.17 0.14 0.18 0.29 0.27 0.12
0.15 0.03 0.14 0.06 0.13 0.17 0.18 0.20 0.33 0.19
0.03 0.03 0.08 0.05 0.12 0.21 0.26 0.30 0.52 0.59
0.04 0.06 0.12 0.11 0.20 0.35 0.45 0.56 0.66 0.59
0.02 0.02 0.11 0.23 0.26 0.35 0.52 0.63 0.54 0.37
-0.06 -0.02 0.01 0.04 0.21 0.33 0.44 0.42 0.54 0.50
-0.05 0.01 0.06 0.15 0.22 0.27 0.41 0.51 0.52 0.49
0.07 0.12 0.13 0.38 0.36 0.51 0.51 0.61 0.67 0.18
0.01 0.07 0.21 0.29 0.42 0.46 0.58 0.74 0.45 0.30
0.05 0.12 0.26 0.31 0.41 0.53 0.65 0.54 0.34 0.21
-0.02 0.08 0.11 0.15 0.17 0.38 0.44 0.43 0.36 0.32
-0.07 0.06 0.09 0.14 0.27 0.35 0.30 0.33 0.31 0.31
-0.02 0.23 0.05 0.15 0.15 0.10 0.21 0.30 0.35 0.34
-0.21 -0.13 0.04 0.06 0.07 0.20 0.18 0.25 0.29 0.32
-0.12 -0.13 -0.03 0.11 0.13 0.06 0.14 0.22 0.35 0.34
-0.13 -0.05 -0.03 0.01 0.08 0.06 0.12 0.25 0.33 0.36
-0.12 -0.23 0.02 -0.00 0.02 -0.02 0.12 0.16 0.26 0.30
-0.40 -0.21 -0.02 0.06 0.09 0.04 0.11 0.24 0.25 0.32
-0.33 -0.07 -0.27 -0.17 -0.06 0.18 0.12 0.16 0.09 0.17
-0.06 -0.32 -0.12 -0.12 -0.58 -0.25 -0.02 0.08 0.13 0.13
-0.06 -0.32 -0.25 -0.09 -0.06 0.00 -0.17 -0.25 0.08 0.11

Chart 20.—East component surface wind stress for August.

NCC - TDF-11 - ONE DEGREE SUMMARIZATION



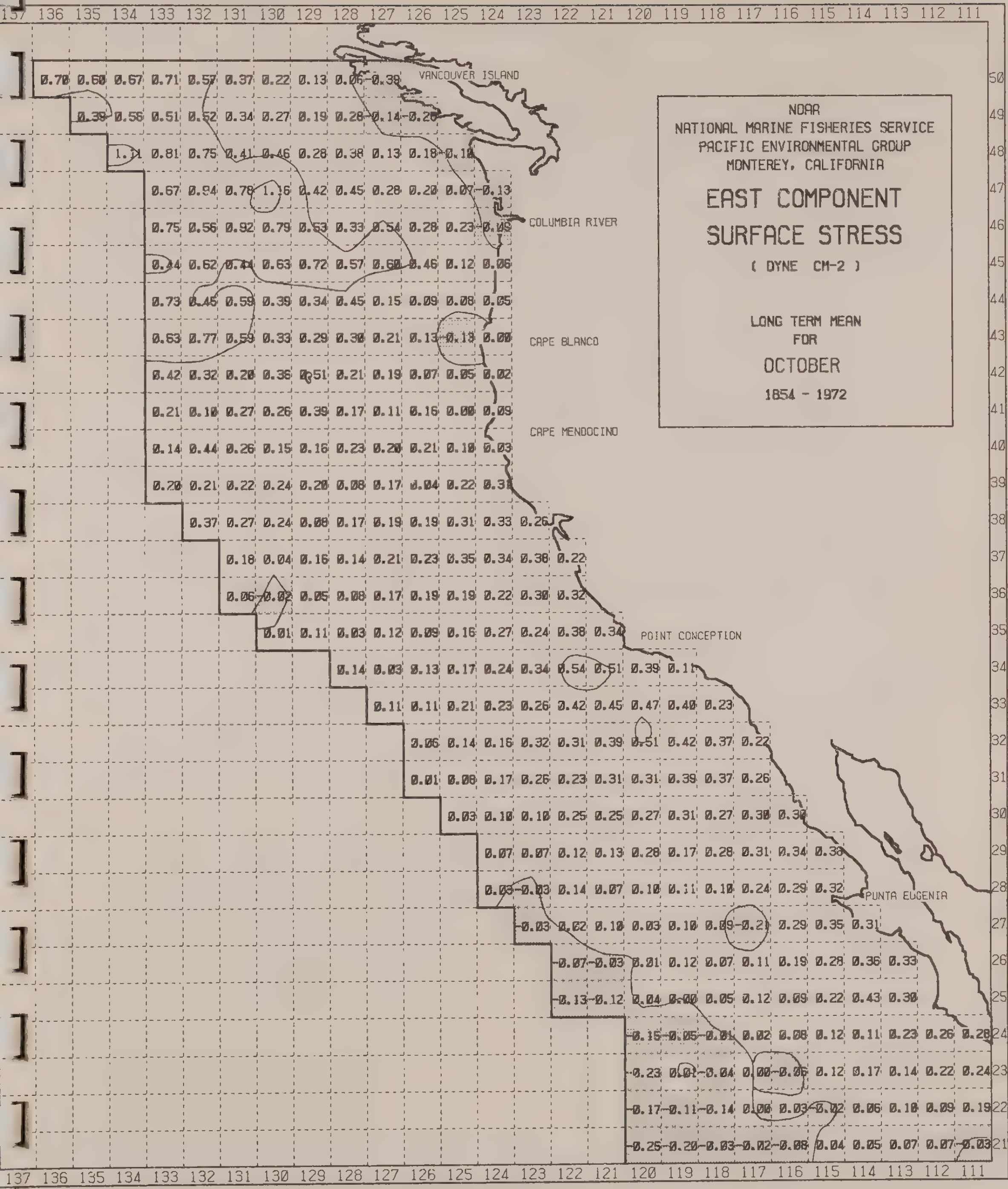
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA

EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)

LONG TERM MEAN
FOR
SEPTEMBER
1854 - 1972

	137	136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112
50		0.55	0.48	0.53	0.44	0.42	0.36	0.33	0.11	0.08	-0.03															
49			0.72	0.62	0.56	0.50	0.36	0.31	0.34	0.30	0.19	0.00														
48				0.59	0.68	0.44	0.32	0.36	0.50	0.39	0.18	0.15	0.07													
47					0.38	0.29	0.29	0.39	0.49	0.39	0.53	0.37	0.15	0.08												
46					0.46	0.42	0.47	0.42	0.26	0.40	0.18	0.64	0.19	0.05												
45					0.31	0.47	0.21	0.29	0.56	0.37	0.32	0.34	0.07	0.10												
44					0.28	0.33	0.17	0.16	0.19	0.19	0.39	0.23	0.03	0.07												
43					0.33	0.18	0.06	0.11	0.24	0.27	0.00	0.02	0.00	0.01												
42					0.19	0.23	0.11	0.29	0.29	0.00	0.12	0.05	0.11	-0.04												
41					0.05	0.06	0.09	0.10	0.18	0.11	-0.10	0.14	0.13	0.09												
40					0.04	0.06	-0.01	0.22	0.14	0.09	0.11	0.13	0.28	0.17												
39					-0.12	-0.02	0.00	-0.00	0.02	0.10	0.10	0.15	0.38	0.37												
38						0.02	0.00	0.03	0.09	0.06	0.17	0.24	0.39	0.47	0.37											
37							-0.00	-0.01	0.06	0.12	0.22	0.28	0.39	0.46	0.41	0.33										
36							-0.02	-0.10	0.03	0.06	0.19	0.23	0.27	0.29	0.38	0.41										
35								-0.07	0.04	0.06	0.11	0.17	0.30	0.27	0.35	0.42	0.39									
34										0.03	0.09	0.25	0.22	0.35	0.39	0.44	0.59	0.51	0.20							
33											-0.03	0.10	0.18	0.22	0.32	0.42	0.66	0.66	0.45	0.29						
32												0.03	0.14	0.18	0.32	0.33	0.48	0.54	0.49	0.35	0.13					
31												0.01	0.05	0.02	0.20	0.29	0.43	0.41	0.37	0.37	0.32					
30													0.05	0.04	0.21	0.22	0.27	0.32	0.34	0.35	0.34	0.33				
29														0.01	0.01	0.15	0.09	0.16	0.27	0.16	0.31	0.36	0.50			
28														-0.05	0.04	0.05	0.12	0.14	0.27	0.22	0.17	0.28	0.33			
27															-0.09	-0.14	0.13	0.11	0.15	0.21	0.16	0.24	0.37	0.33		
26																-0.06	0.02	0.04	0.10	0.18	0.15	0.22	0.22	0.34	0.32	
25																-0.14	-0.24	0.08	0.00	0.10	0.25	0.37	0.17	0.26	0.28	
24																		-0.10	0.00	0.08	0.12	0.10	0.20	0.29	0.28	0.23
23																		-0.18	-0.16	-0.09	0.22	0.06	0.15	0.14	0.26	0.25
22																		-0.09	-0.28	0.00	-0.25	0.39	0.33	0.06	0.19	0.22
21																		-0.03	-0.03	-0.04	0.18	0.07	0.08	0.40	0.16	0.30

Chart 21.—East component surface wind stress for September.

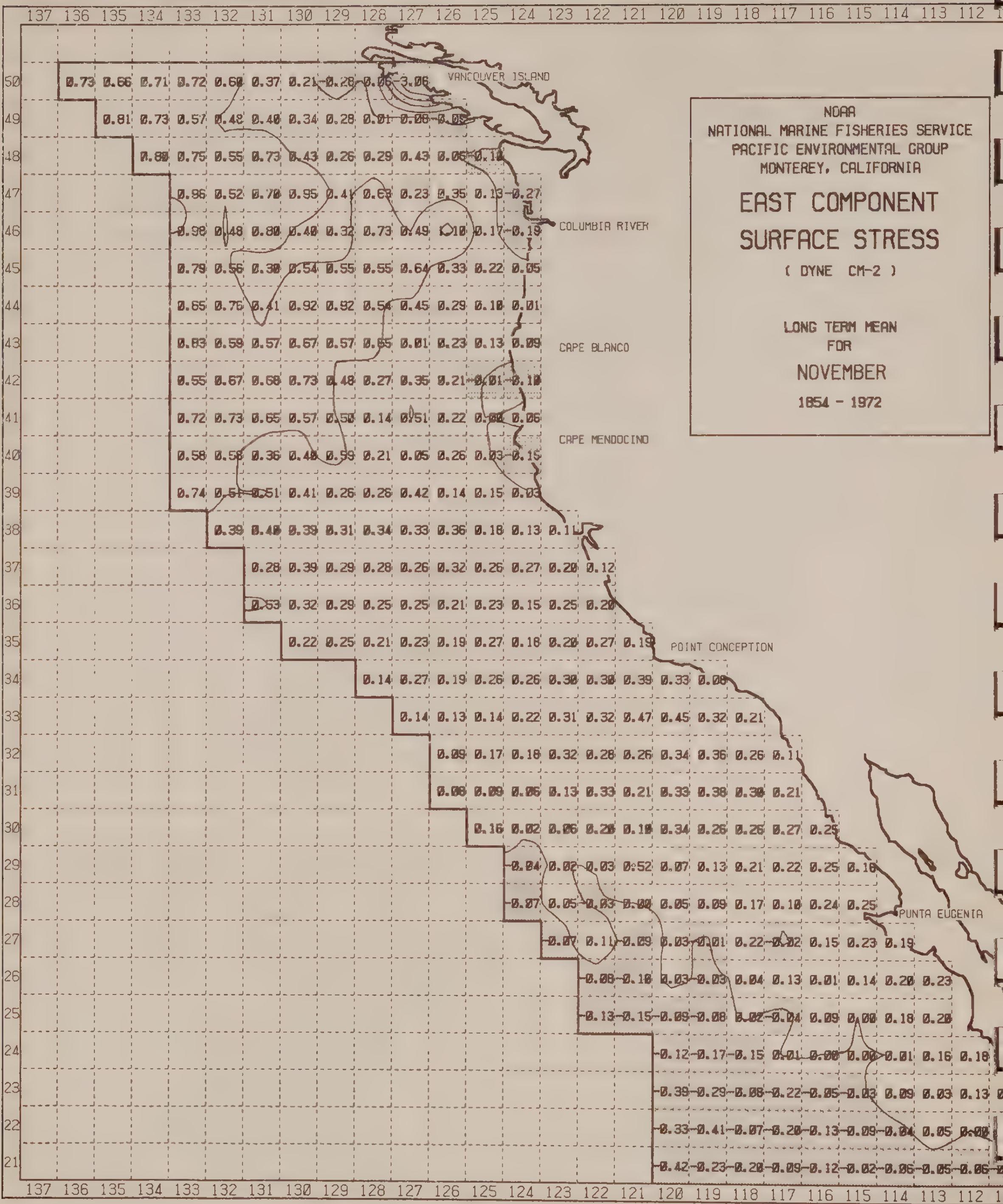


- TDF-11 - ONE DEGREE SUMMARIZATION
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
OCTOBER
1854 - 1972

136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112	111	
0.70	0.60	0.67	0.71	0.57	0.37	0.22	0.13	0.06	-0.39																	50
	0.39	0.56	0.51	0.52	0.34	0.27	0.19	0.28	-0.14	-0.26																49
		1.11	0.81	0.75	0.41	0.46	0.28	0.38	0.13	0.18	-0.10															48
			0.67	0.94	0.78	1.16	0.42	0.45	0.28	0.20	0.07	-0.13														47
			0.75	0.56	0.92	0.79	0.53	0.33	0.54	0.28	0.23	-0.05														46
			0.44	0.62	0.44	0.63	0.72	0.57	0.60	0.46	0.12	0.06														45
			0.73	0.45	0.59	0.39	0.34	0.45	0.15	0.09	0.08	0.05														44
			0.63	0.77	0.59	0.33	0.29	0.30	0.21	0.13	-0.13	0.00														43
			0.42	0.32	0.20	0.36	0.51	0.21	0.19	0.07	0.05	0.02														42
			0.21	0.10	0.27	0.26	0.39	0.17	0.11	0.16	0.00	0.09														41
			0.14	0.44	0.26	0.15	0.16	0.23	0.20	0.21	0.10	0.03														40
			0.20	0.21	0.22	0.24	0.20	0.08	0.17	0.04	0.22	0.31														39
				0.37	0.27	0.24	0.08	0.17	0.19	0.19	0.31	0.33	0.26													38
					0.18	0.04	0.16	0.14	0.21	0.23	0.35	0.34	0.38	0.22												37
					0.06	-0.02	0.05	0.08	0.17	0.19	0.19	0.22	0.30	0.32												36
						0.01	0.11	0.03	0.12	0.09	0.16	0.27	0.24	0.38	0.34											35
								0.14	0.03	0.13	0.17	0.24	0.34	0.54	0.51	0.39	0.11									34
									0.11	0.11	0.21	0.23	0.26	0.42	0.45	0.47	0.40	0.23								33
										0.06	0.14	0.16	0.32	0.31	0.39	0.51	0.42	0.37	0.22							32
										0.01	0.08	0.17	0.26	0.23	0.31	0.31	0.39	0.37	0.26							31
											0.03	0.10	0.10	0.25	0.25	0.27	0.31	0.27	0.30	0.30						30
												0.07	0.07	0.12	0.13	0.28	0.17	0.28	0.31	0.34	0.38					29
												0.03	-0.03	0.14	0.07	0.10	0.11	0.10	0.24	0.29	0.32					28
													-0.03	0.02	0.10	0.03	0.10	0.09	-0.21	0.29	0.35	0.31				27
														-0.07	-0.03	0.01	0.12	0.07	0.11	0.19	0.28	0.36	0.33			26
														-0.13	-0.12	0.04	0.00	0.05	0.12	0.09	0.22	0.43	0.30			25
																-0.15	-0.05	-0.01	0.02	0.08	0.12	0.11	0.23	0.26	0.28	24
																-0.23	0.01	-0.04	0.00	-0.06	0.12	0.17	0.14	0.22	0.24	23
																-0.17	-0.11	-0.14	0.00	0.03	-0.02	0.06	0.10	0.09	0.19	22
																-0.25	-0.20	-0.03	-0.02	-0.08	0.04	0.05	0.07	0.07	-0.03	21

Chart 22.—East component surface wind stress for October.

NCC - TDF-11 - ONE DEGREE SUMMARIZATION


137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA

NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA

EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)

LONG TERM MEAN
FOR
NOVEMBER
1854 - 1972

	136	135	134	133	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113	112
50	0.73	0.66	0.71	0.72	0.60	0.37	0.21	-0.20	-0.06	-3.06															
49		0.81	0.73	0.57	0.42	0.40	0.34	0.28	0.01	-0.08	-0.05														
48			0.80	0.75	0.55	0.73	0.43	0.26	0.29	0.43	0.06	-0.10													
47				0.96	0.52	0.70	0.95	0.41	0.63	0.23	0.35	0.13	-0.27												
46				0.98	0.48	0.80	0.40	0.32	0.73	0.49	0.10	0.17	-0.19												
45				0.79	0.56	0.30	0.54	0.55	0.55	0.64	0.33	0.22	0.05												
44				0.65	0.76	0.41	0.92	0.92	0.54	0.45	0.29	0.10	0.01												
43				0.83	0.59	0.57	0.67	0.57	0.65	0.01	0.23	0.13	0.09												
42				0.55	0.67	0.68	0.73	0.48	0.27	0.35	0.21	-0.01	-0.10												
41				0.72	0.73	0.65	0.57	0.50	0.14	0.51	0.22	0.00	0.06												
40				0.58	0.58	0.36	0.40	0.59	0.21	0.05	0.26	0.03	-0.15												
39				0.74	0.51	0.51	0.41	0.26	0.26	0.42	0.14	0.15	0.03												
38					0.39	0.40	0.39	0.31	0.34	0.33	0.36	0.18	0.13	0.11											
37						0.28	0.39	0.29	0.28	0.26	0.32	0.26	0.27	0.20	0.12										
36						0.53	0.32	0.29	0.25	0.25	0.21	0.23	0.15	0.25	0.20										
35							0.22	0.25	0.21	0.23	0.19	0.27	0.18	0.20	0.27	0.19									
34									0.14	0.27	0.19	0.26	0.26	0.30	0.30	0.39	0.33	0.08							
33										0.14	0.13	0.14	0.22	0.31	0.32	0.47	0.45	0.32	0.21						
32											0.09	0.17	0.18	0.32	0.28	0.26	0.34	0.36	0.26	0.11					
31											0.08	0.09	0.06	0.13	0.33	0.21	0.33	0.38	0.30	0.21					
30												0.16	0.02	0.06	0.20	0.10	0.34	0.26	0.26	0.27	0.25				
29													-0.04	0.02	0.03	0.52	0.07	0.13	0.21	0.22	0.25	0.18			
28													-0.07	0.05	-0.03	0.00	0.05	0.09	0.17	0.10	0.24	0.25			
27														-0.07	0.11	-0.09	0.03	-0.01	0.22	-0.02	0.15	0.23	0.19		
26															-0.08	-0.10	0.03	-0.03	0.04	0.13	0.01	0.14	0.20	0.23	
25															-0.13	-0.15	-0.09	-0.08	0.02	-0.04	0.09	0.00	0.18	0.20	
24																	-0.12	-0.17	-0.15	0.01	0.00	0.00	-0.01	0.16	0.18
23																	-0.39	-0.29	-0.08	-0.22	-0.05	-0.03	0.09	0.03	0.13
22																	-0.33	-0.41	-0.07	-0.20	-0.13	-0.09	-0.04	0.05	0.00
21																	-0.42	-0.23	-0.20	-0.09	-0.12	-0.02	-0.06	-0.05	-0.06

Chart 23.—East component surface wind stress for November.

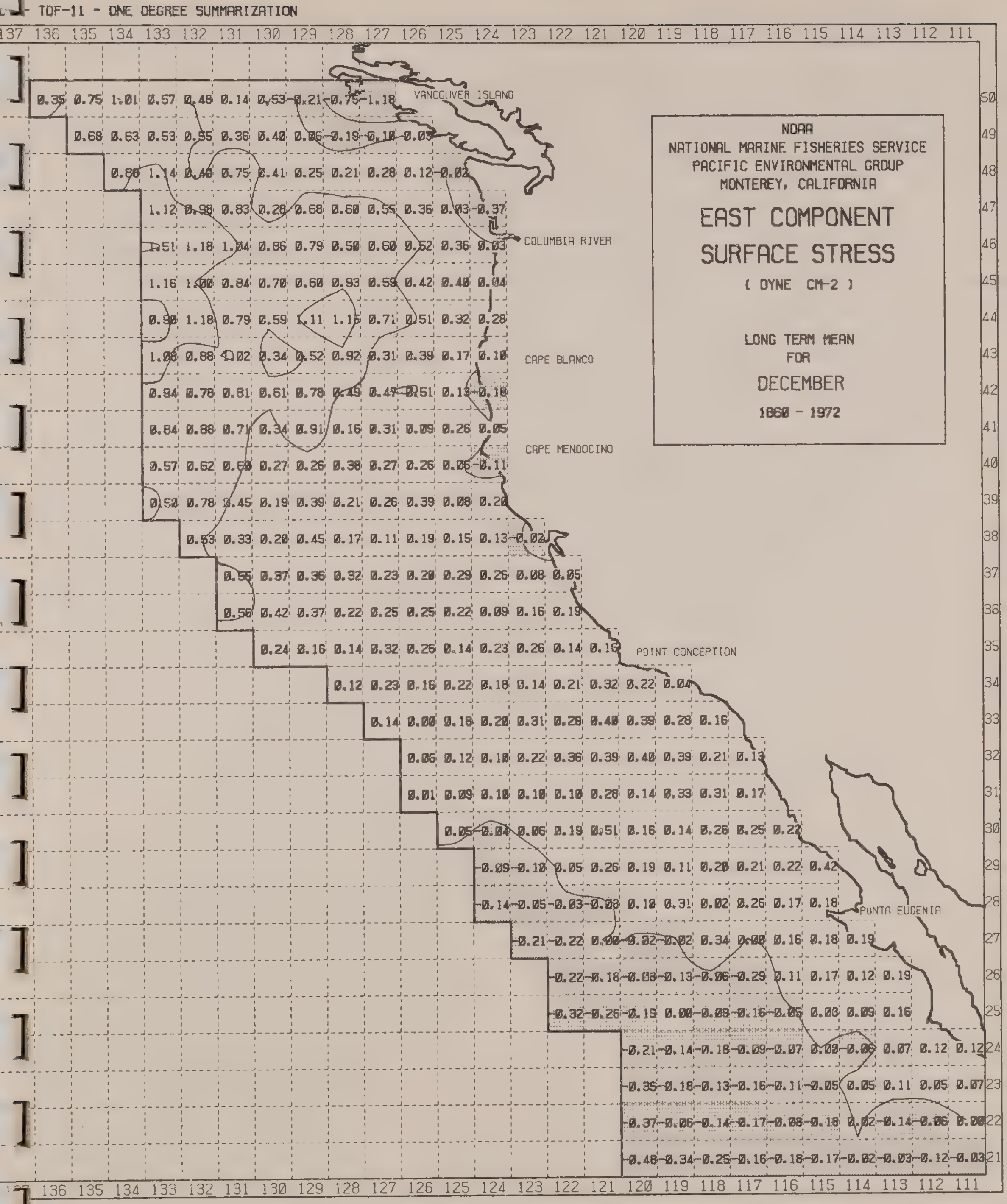

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
EAST COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
DECEMBER
1860 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.35 0.75 1.01 0.57 0.48 0.14 0.53 -0.21 -0.75 -1.18
49 0.68 0.63 0.53 0.55 0.36 0.40 0.06 -0.19 -0.10 -0.03
48 0.86 1.14 0.40 0.75 0.41 0.25 0.21 0.28 0.12 -0.02
47 1.12 0.98 0.83 0.28 0.68 0.60 0.55 0.36 0.03 -0.37
46 1.51 1.18 1.04 0.86 0.79 0.50 0.60 0.52 0.36 0.03
45 1.16 1.00 0.84 0.70 0.60 0.93 0.59 0.42 0.40 0.04
44 0.90 1.18 0.79 0.59 1.11 1.16 0.71 0.51 0.32 0.28
43 1.06 0.88 1.02 0.34 0.52 0.92 0.31 0.39 0.17 0.10
42 0.84 0.78 0.81 0.61 0.78 0.49 0.47 -0.51 0.13 -0.10
41 0.84 0.88 0.71 0.34 0.91 0.16 0.31 0.09 0.26 0.05
40 0.57 0.62 0.60 0.27 0.26 0.38 0.27 0.26 0.06 -0.11
39 0.52 0.78 3.45 0.19 0.39 0.21 0.26 0.39 0.08 0.20
38 0.53 0.33 0.20 0.45 0.17 0.11 0.19 0.15 0.13 -0.02
37 0.55 0.37 0.36 0.32 0.23 0.20 0.29 0.26 0.08 0.05
36 0.56 0.42 0.37 0.22 0.25 0.25 0.22 0.09 0.16 0.19
35 0.24 0.16 0.14 0.32 0.26 0.14 0.23 0.26 0.14 0.16
34 0.12 0.23 0.16 0.22 0.18 0.14 0.21 0.32 0.22 0.04
33 0.14 0.00 0.18 0.20 0.31 0.29 0.40 0.39 0.28 0.16
32 0.06 0.12 0.10 0.22 0.36 0.39 0.40 0.39 0.21 0.13
31 0.01 0.09 0.10 0.10 0.10 0.28 0.14 0.33 0.31 0.17
30 0.05 -0.04 0.06 0.19 0.51 0.16 0.14 0.26 0.25 0.22
29 -0.09 -0.10 0.05 0.26 0.19 0.11 0.20 0.21 0.22 0.42
28 -0.14 -0.05 -0.03 -0.03 0.10 0.31 0.02 0.26 0.17 0.18
27 -0.21 -0.22 0.00 -0.02 -0.02 0.34 0.00 0.16 0.18 0.19
26 -0.22 -0.16 -0.08 -0.13 -0.06 -0.29 0.11 0.17 0.12 0.19
25 -0.32 -0.26 -0.15 0.00 -0.09 -0.16 -0.05 0.03 0.09 0.16
24 -0.21 -0.14 -0.18 -0.09 -0.07 0.00 -0.06 0.07 0.12 0.12
23 -0.35 -0.18 -0.13 -0.16 -0.11 -0.05 0.05 0.11 0.05 0.07
22 -0.37 -0.06 -0.14 -0.17 -0.08 -0.18 0.02 -0.14 -0.06 0.00
21 -0.48 -0.34 -0.25 -0.16 -0.18 -0.17 -0.02 -0.03 -0.12 -0.03
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 24.—East component surface wind stress for December.

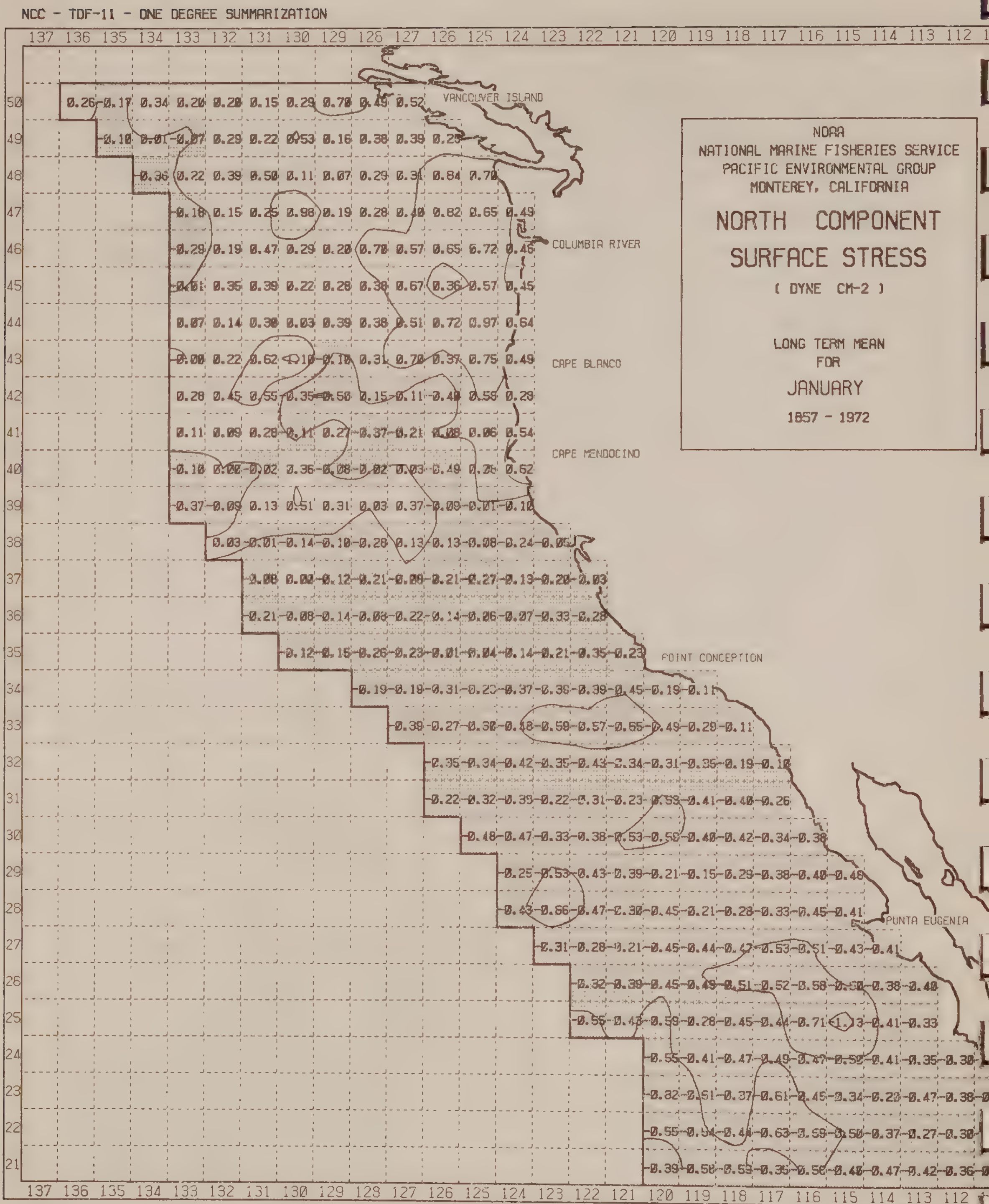

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JANUARY
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.26 -0.17 0.34 0.20 0.20 0.15 0.29 0.70 0.49 0.52
49 -0.10 -0.01 -0.07 0.29 0.22 0.53 0.16 0.38 0.39 0.25
48 -0.36 0.22 0.39 0.50 0.11 0.07 0.29 0.31 0.84 0.70
47 -0.10 0.15 0.25 0.98 0.19 0.28 0.40 0.82 0.65 0.49
46 -0.29 0.19 0.47 0.29 0.20 0.70 0.57 0.65 0.72 0.46
45 -0.01 0.35 0.39 0.22 0.28 0.38 0.67 0.36 0.57 0.45
44 0.07 0.14 0.30 0.03 0.39 0.38 0.51 0.72 0.97 0.64
43 -0.00 0.22 0.62 -0.10 -0.10 0.31 0.70 0.37 0.75 0.49
42 0.28 0.45 0.55 -0.35 -0.50 0.15 -0.11 -0.40 0.58 0.29
41 0.11 0.09 0.28 -0.11 0.27 -0.37 -0.21 0.08 0.06 0.54
40 -0.10 0.00 -0.02 0.36 -0.08 -0.02 0.03 -0.49 0.26 0.62
39 -0.37 -0.09 0.13 0.51 0.31 0.03 0.37 -0.09 -0.01 -0.10
38 0.03 -0.01 -0.14 -0.10 -0.28 0.13 -0.13 -0.08 -0.24 -0.05
37 -0.08 0.00 -0.12 -0.21 -0.08 -0.21 -0.27 -0.13 -0.20 -0.03
36 -0.21 -0.08 -0.14 -0.08 -0.22 -0.14 -0.06 -0.07 -0.33 -0.28
35 -0.12 -0.15 -0.26 -0.23 -0.01 -0.04 -0.14 -0.21 -0.35 -0.23
34 -0.19 -0.19 -0.31 -0.20 -0.37 -0.38 -0.39 -0.45 -0.19 -0.11
33 -0.39 -0.27 -0.30 -0.48 -0.58 -0.57 -0.65 -0.49 -0.29 -0.11
32 -0.35 -0.34 -0.42 -0.35 -0.43 -0.34 -0.31 -0.35 -0.19 -0.10
31 -0.22 -0.32 -0.39 -0.22 -0.31 -0.23 -0.53 -0.41 -0.40 -0.26
30 -0.48 -0.47 -0.33 -0.38 -0.53 -0.58 -0.40 -0.42 -0.34 -0.38
29 -0.25 -0.53 -0.43 -0.39 -0.21 -0.15 -0.29 -0.38 -0.40 -0.48
28 -0.43 -0.66 -0.47 -0.30 -0.45 -0.21 -0.28 -0.33 -0.45 -0.41
27 -0.31 -0.28 -0.21 -0.45 -0.44 -0.47 -0.53 -0.51 -0.43 -0.41
26 -0.32 -0.39 -0.45 -0.49 -0.51 -0.52 -0.58 -0.50 -0.38 -0.40
25 -0.55 -0.43 -0.59 -0.28 -0.45 -0.44 -0.71 -1.13 -0.41 -0.33
24 -0.55 -0.41 -0.47 -0.49 -0.47 -0.52 -0.41 -0.35 -0.30
23 -0.82 -0.51 -0.37 -0.61 -0.45 -0.34 -0.29 -0.47 -0.38
22 -0.55 -0.54 -0.44 -0.63 -0.59 -0.50 -0.37 -0.27 -0.30
21 -0.39 -0.58 -0.53 -0.35 -0.56 -0.46 -0.47 -0.42 -0.36
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112

Chart 25.—North component surface wind stress for January.

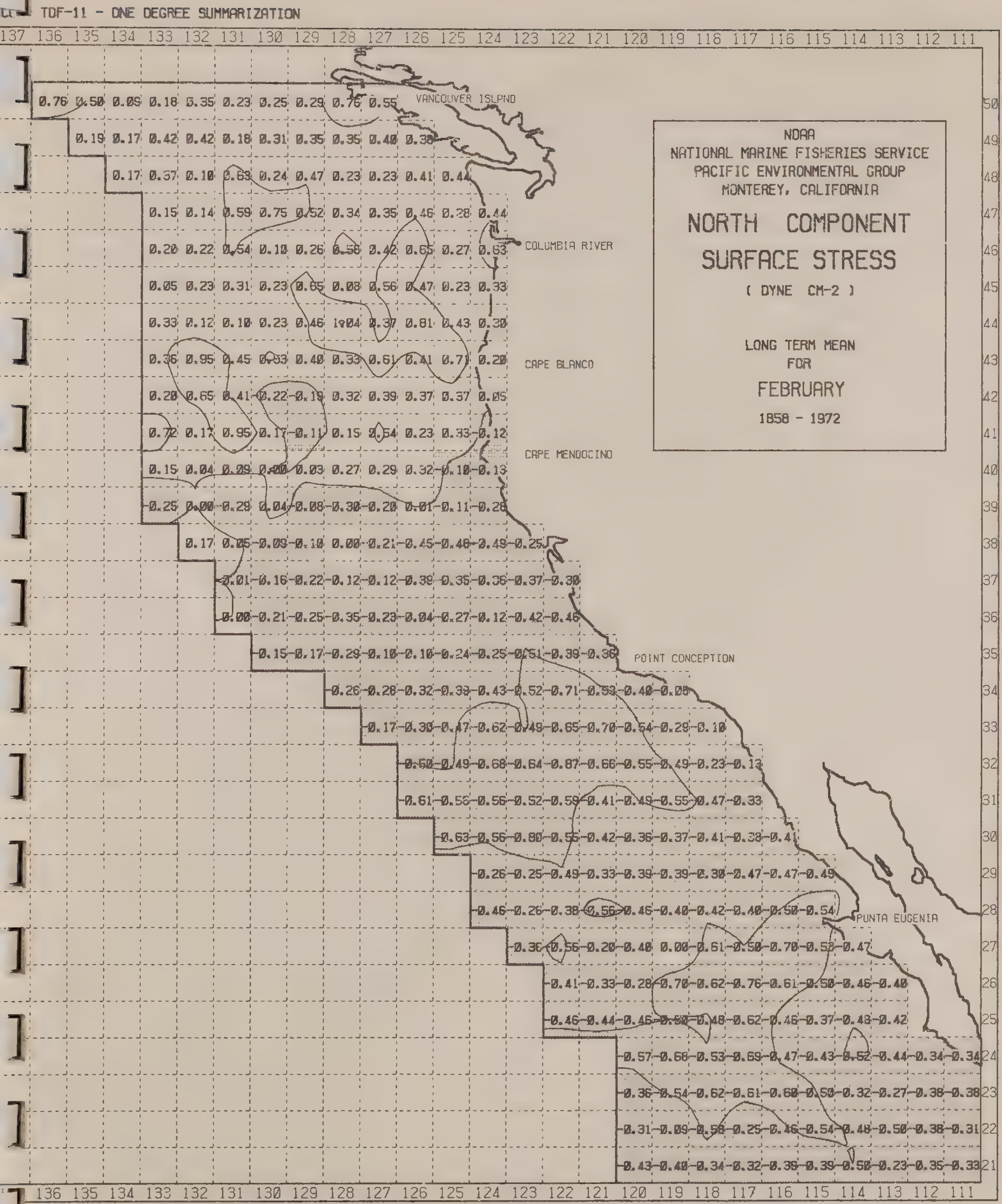

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
FEBRUARY
1858 - 1972
0.76 0.50 0.05 0.18 0.35 0.23 0.25 0.29 0.76 0.55
0.19 0.17 0.42 0.42 0.18 0.31 0.35 0.35 0.40 0.38
0.17 0.37 0.10 0.63 0.24 0.47 0.23 0.23 0.41 0.44
0.15 0.14 0.59 0.75 0.52 0.34 0.35 0.46 0.28 0.44
0.20 0.22 0.54 0.10 0.26 0.56 0.42 0.65 0.27 0.63
0.05 0.23 0.31 0.23 0.65 0.08 0.56 0.47 0.23 0.33
0.33 0.12 0.10 0.23 0.46 1.04 0.37 0.81 0.43 0.30
0.36 0.95 0.45 0.53 0.40 0.33 0.61 0.41 0.71 0.20
0.20 0.65 0.41 -0.22 -0.19 0.32 0.39 0.37 0.37 0.05
0.72 0.17 0.95 0.17 -0.11 0.15 0.54 0.23 0.33 -0.12
0.15 0.04 0.09 0.00 0.03 0.27 0.29 0.32 -0.10 -0.13
-0.25 0.00 -0.29 0.04 -0.08 -0.30 -0.20 0.01 -0.11 -0.28
0.17 0.05 -0.09 -0.10 0.00 -0.21 -0.45 -0.48 -0.49 -0.25
-0.01 -0.16 -0.22 -0.12 -0.12 -0.39 -0.35 -0.36 -0.37 -0.30
0.00 -0.21 -0.25 -0.35 -0.23 -0.04 -0.27 -0.12 -0.42 -0.46
-0.15 -0.17 -0.29 -0.10 -0.10 -0.24 -0.25 -0.51 -0.39 -0.36
-0.26 -0.28 -0.32 -0.33 -0.43 -0.52 -0.71 -0.53 -0.40 -0.05
-0.17 -0.30 -0.47 -0.62 -0.49 -0.65 -0.70 -0.54 -0.28 -0.10
-0.60 -0.49 -0.68 -0.64 -0.87 -0.66 -0.55 -0.49 -0.23 -0.13
-0.61 -0.56 -0.56 -0.52 -0.59 -0.41 -0.49 -0.55 -0.47 -0.33
-0.63 -0.56 -0.80 -0.55 -0.42 -0.36 -0.37 -0.41 -0.38 -0.41
-0.26 -0.25 -0.49 -0.33 -0.39 -0.39 -0.30 -0.47 -0.47 -0.49
-0.46 -0.26 -0.38 -0.56 -0.46 -0.40 -0.42 -0.40 -0.50 -0.54
-0.36 -0.56 -0.20 -0.40 0.00 -0.61 -0.50 -0.70 -0.53 -0.47
-0.41 -0.33 -0.28 -0.70 -0.62 -0.76 -0.61 -0.50 -0.46 -0.40
-0.46 -0.44 -0.46 -0.50 -0.48 -0.62 -0.46 -0.37 -0.43 -0.42
-0.57 -0.68 -0.53 -0.69 -0.47 -0.43 -0.52 -0.44 -0.34 -0.34
-0.36 -0.54 -0.62 -0.61 -0.60 -0.50 -0.32 -0.27 -0.38 -0.38
-0.31 -0.09 -0.58 -0.25 -0.46 -0.54 -0.48 -0.50 -0.38 -0.31
-0.43 -0.40 -0.34 -0.32 -0.39 -0.39 -0.50 -0.23 -0.35 -0.33

Chart 26.—North component surface wind stress for February.

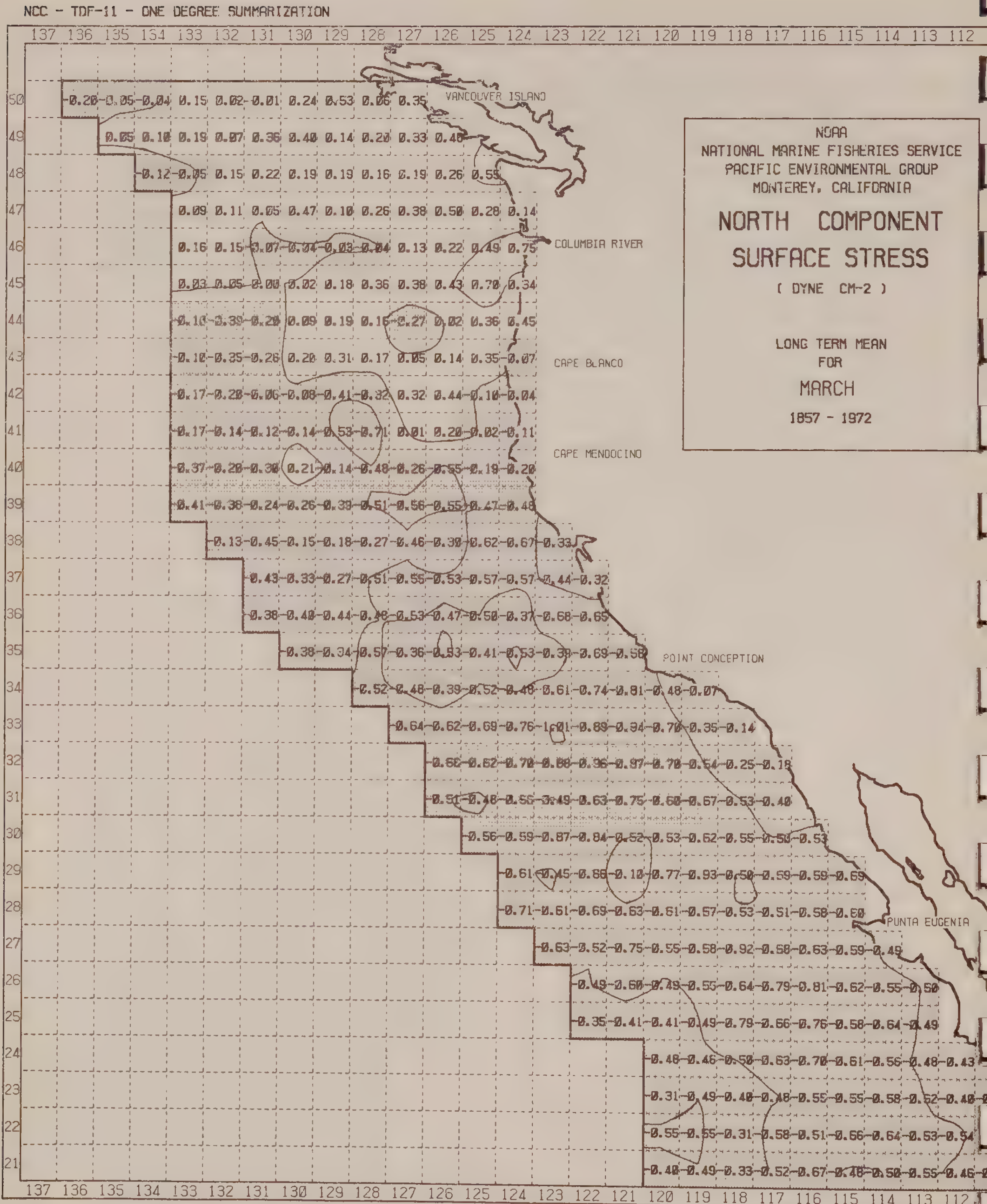

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
MARCH
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21

Chart 27.—North component surface wind stress for March.

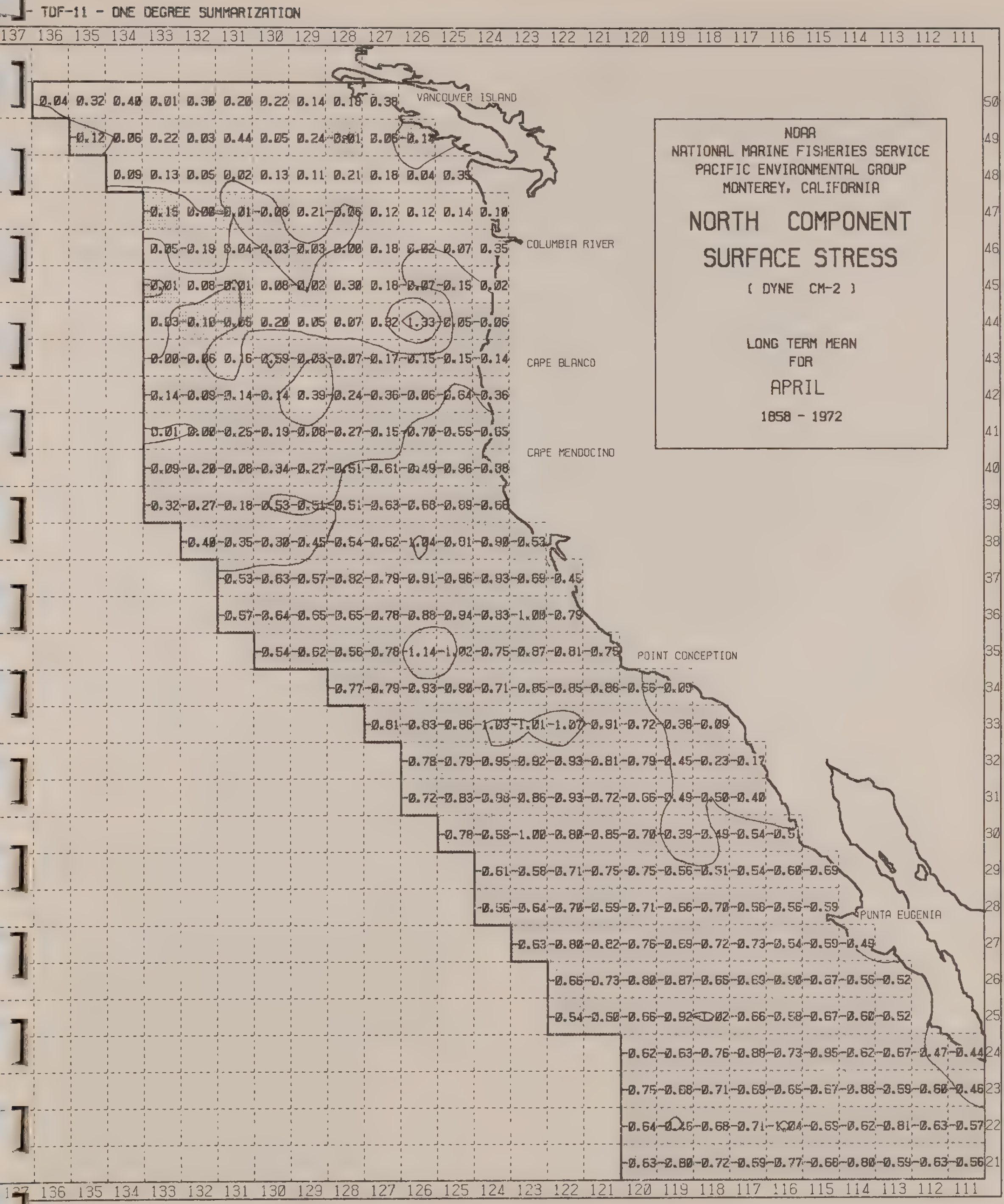

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
APRIL
1850 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.04 0.32 0.40 0.01 0.30 0.20 0.22 0.14 0.18 0.38
49 -0.12 0.06 0.22 0.03 0.44 0.05 0.24 -0.01 0.06 -0.14
48 0.09 0.13 0.05 0.02 0.13 0.11 0.21 0.18 0.04 0.35
47 -0.15 0.00 -0.01 -0.08 0.21 -0.06 0.12 0.12 0.14 0.10
46 0.05 -0.19 0.04 -0.03 -0.03 0.00 0.18 0.02 0.07 0.35
45 -0.01 0.08 -0.01 0.08 -0.02 0.30 0.18 -0.07 -0.15 0.02
44 0.03 -0.10 -0.05 0.20 0.05 0.07 0.32 1.33 0.05 -0.06
43 -0.00 -0.06 0.16 -0.59 -0.03 -0.07 -0.17 -0.15 -0.15 -0.14
42 -0.14 -0.09 -0.14 -0.14 0.39 -0.24 -0.36 -0.06 -0.64 -0.36
41 0.01 0.00 -0.25 -0.19 -0.08 -0.27 -0.15 -0.70 -0.55 -0.65
40 -0.09 -0.20 -0.08 -0.34 -0.27 -0.51 -0.61 -0.49 -0.96 -0.38
39 -0.32 -0.27 -0.18 -0.53 -0.51 -0.51 -0.63 -0.66 -0.89 -0.66
38 -0.40 -0.35 -0.30 -0.45 -0.54 -0.62 -1.04 -0.81 -0.90 -0.53
37 -0.53 -0.63 -0.57 -0.82 -0.79 -0.91 -0.96 -0.93 -0.69 -0.45
36 -0.57 -0.64 -0.65 -0.65 -0.78 -0.88 -0.94 -0.83 -1.00 -0.79
35 -0.54 -0.62 -0.56 -0.78 -1.14 -1.02 -0.75 -0.87 -0.81 -0.75
34 -0.77 -0.79 -0.93 -0.90 -0.71 -0.85 -0.85 -0.86 -0.66 -0.09
33 -0.81 -0.83 -0.86 -1.03 -1.01 -1.07 -0.91 -0.72 -0.38 -0.09
32 -0.78 -0.79 -0.95 -0.92 -0.93 -0.81 -0.79 -0.45 -0.23 -0.17
31 -0.72 -0.83 -0.98 -0.86 -0.93 -0.72 -0.66 -0.49 -0.50 -0.40
30 -0.78 -0.58 -1.00 -0.80 -0.85 -0.70 -0.39 -0.49 -0.54 -0.51
29 -0.61 -0.58 -0.71 -0.75 -0.75 -0.56 -0.51 -0.54 -0.60 -0.69
28 -0.56 -0.64 -0.70 -0.59 -0.71 -0.66 -0.70 -0.56 -0.56 -0.59
27 -0.63 -0.80 -0.82 -0.76 -0.69 -0.72 -0.73 -0.54 -0.59 -0.49
26 -0.66 -0.73 -0.80 -0.87 -0.65 -0.69 -0.90 -0.67 -0.56 -0.52
25 -0.54 -0.60 -0.66 -0.92 -1.02 -0.66 -0.58 -0.67 -0.60 -0.52
24 -0.62 -0.63 -0.76 -0.88 -0.73 -0.95 -0.62 -0.67 -0.47 -0.44
23 -0.75 -0.68 -0.71 -0.69 -0.65 -0.67 -0.88 -0.59 -0.60 -0.46
22 -0.64 -0.46 -0.68 -0.71 -1.04 -0.59 -0.62 -0.81 -0.63 -0.57
21 -0.63 -0.80 -0.72 -0.59 -0.77 -0.68 -0.80 -0.59 -0.63 -0.56

Chart 28.—North component surface wind stress for April.

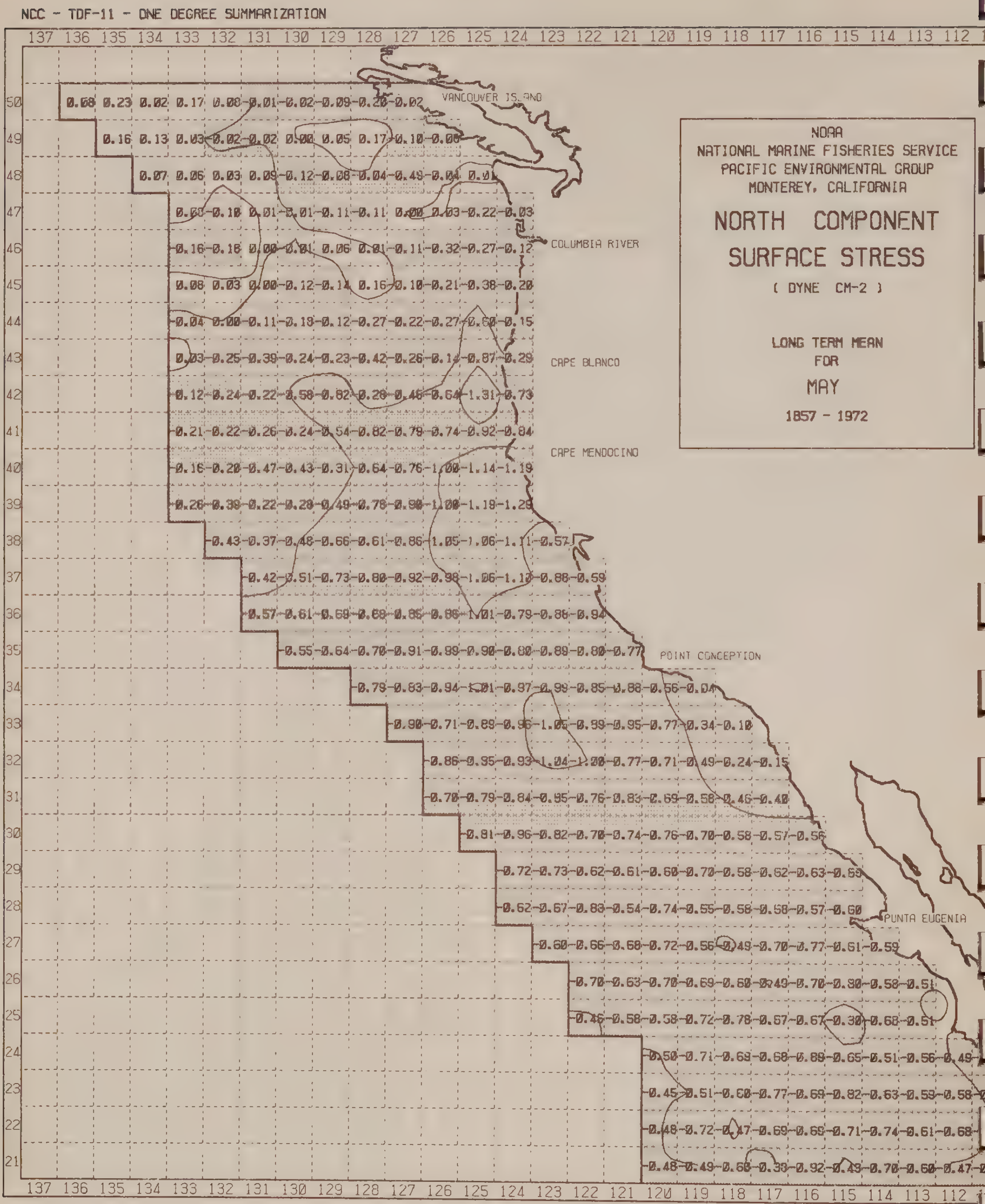

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
MAY
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.68 0.23 0.02 0.17 0.08 -0.01 -0.02 -0.09 -0.20 -0.02
0.16 0.13 0.03 -0.02 -0.02 0.00 0.05 0.17 -0.10 -0.06
0.07 0.06 0.03 0.09 -0.12 -0.08 -0.04 -0.49 -0.04 0.01
0.03 -0.10 0.01 -0.01 -0.11 -0.11 0.00 0.03 -0.22 -0.03
-0.16 -0.16 0.00 -0.01 0.06 0.01 -0.11 -0.32 -0.27 -0.12
0.08 0.03 0.00 -0.12 -0.14 0.16 -0.10 -0.21 -0.38 -0.20
-0.04 0.00 -0.11 -0.19 -0.12 -0.27 -0.22 -0.27 -0.60 -0.15
0.03 -0.25 -0.39 -0.24 -0.23 -0.42 -0.26 -0.14 -0.87 -0.29
-0.12 -0.24 -0.22 -0.58 -0.82 -0.28 -0.46 -0.64 -1.31 -0.73
-0.21 -0.22 -0.26 -0.24 -0.54 -0.82 -0.78 -0.74 -0.92 -0.84
-0.16 -0.20 -0.47 -0.43 -0.31 -0.64 -0.76 -1.00 -1.14 -1.19
-0.26 -0.38 -0.22 -0.28 -0.49 -0.78 -0.90 -1.00 -1.18 -1.28
-0.43 -0.37 -0.48 -0.66 -0.61 -0.86 -1.05 -1.06 -1.11 -0.57
-0.42 -0.51 -0.73 -0.80 -0.92 -0.98 -1.06 -1.10 -0.88 -0.59
-0.57 -0.61 -0.69 -0.68 -0.85 -0.86 -1.01 -0.79 -0.86 -0.94
-0.55 -0.64 -0.70 -0.91 -0.89 -0.90 -0.80 -0.89 -0.80 -0.77
-0.79 -0.83 -0.94 -1.01 -0.97 -0.99 -0.85 -0.88 -0.56 -0.04
-0.90 -0.71 -0.89 -0.96 -1.05 -0.99 -0.95 -0.77 -0.34 -0.10
-0.86 -0.95 -0.93 -1.04 -1.20 -0.77 -0.71 -0.49 -0.24 -0.15
-0.70 -0.79 -0.84 -0.95 -0.76 -0.83 -0.69 -0.58 -0.46 -0.40
-0.81 -0.96 -0.82 -0.70 -0.74 -0.76 -0.70 -0.58 -0.57 -0.56
-0.72 -0.73 -0.62 -0.61 -0.60 -0.70 -0.58 -0.62 -0.63 -0.69
-0.62 -0.67 -0.83 -0.54 -0.74 -0.55 -0.58 -0.58 -0.57 -0.60
-0.60 -0.66 -0.68 -0.72 -0.56 -0.49 -0.70 -0.77 -0.61 -0.59
-0.70 -0.63 -0.70 -0.69 -0.60 -0.49 -0.70 -0.80 -0.58 -0.51
-0.46 -0.58 -0.58 -0.72 -0.78 -0.57 -0.67 -0.30 -0.68 -0.51
-0.50 -0.71 -0.69 -0.68 -0.89 -0.65 -0.51 -0.56 -0.49
-0.45 -0.51 -0.60 -0.77 -0.69 -0.82 -0.63 -0.59 -0.58
-0.48 -0.72 -0.47 -0.69 -0.69 -0.71 -0.74 -0.61 -0.68
-0.48 -0.49 -0.60 -0.33 -0.92 -0.43 -0.70 -0.60 -0.47

Chart 29.—North component surface wind stress for May.

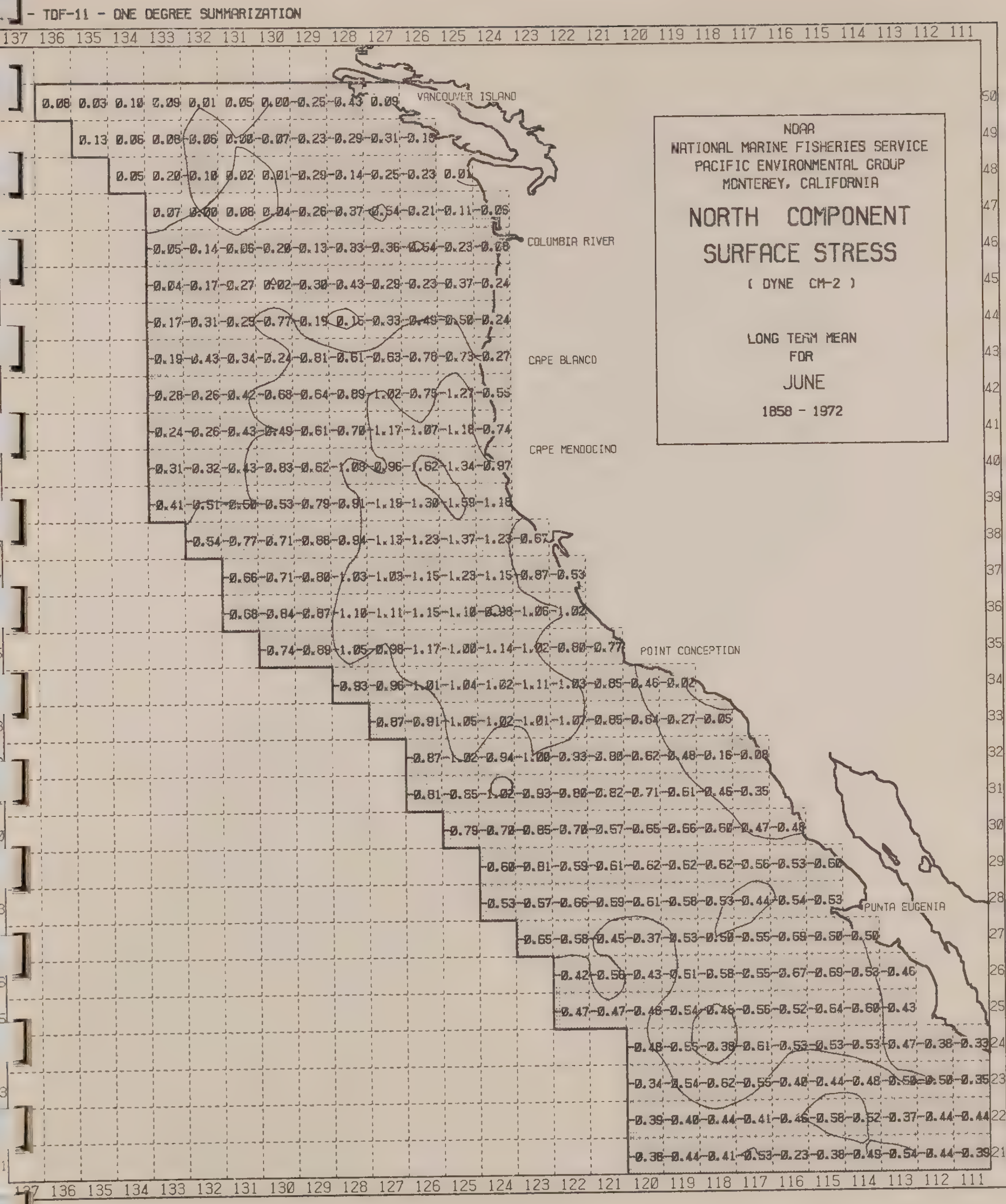

- TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JUNE
1858 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.08 0.03 0.10 0.09 0.01 0.05 0.00 -0.25 -0.43 0.09
49 0.13 0.06 0.08 -0.06 0.00 -0.07 -0.23 -0.29 -0.31 -0.15
48 0.05 0.20 -0.10 0.02 0.01 -0.29 -0.14 -0.25 -0.23 0.01
47 0.07 0.00 0.08 0.04 -0.26 -0.37 -0.54 -0.21 -0.11 -0.06
46 -0.05 -0.14 -0.06 -0.20 -0.13 -0.33 -0.36 -0.54 -0.23 -0.08
45 -0.04 -0.17 -0.27 0.02 -0.30 -0.43 -0.28 -0.23 -0.37 -0.24
44 -0.17 -0.31 -0.25 -0.77 -0.19 0.16 -0.33 -0.49 -0.50 -0.24
43 -0.19 -0.43 -0.34 -0.24 -0.81 -0.61 -0.63 -0.78 -0.73 -0.27
42 -0.28 -0.26 -0.42 -0.68 -0.64 -0.89 -1.02 -0.75 -1.27 -0.55
41 -0.24 -0.26 -0.43 -0.49 -0.61 -0.70 -1.17 -1.07 -1.18 -0.74
40 -0.31 -0.32 -0.43 -0.83 -0.62 -1.08 -0.96 -1.62 -1.34 -0.87
39 -0.41 -0.51 -0.50 -0.53 -0.79 -0.91 -1.19 -1.30 -1.59 -1.18
38 -0.54 -0.77 -0.71 -0.88 -0.94 -1.13 -1.23 -1.37 -1.23 -0.67
37 -0.66 -0.71 -0.80 -1.03 -1.03 -1.15 -1.23 -1.15 -0.87 -0.53
36 -0.68 -0.84 -0.87 -1.10 -1.11 -1.15 -1.10 -0.98 -1.06 -1.02
35 -0.74 -0.89 -1.05 -0.98 -1.17 -1.00 -1.14 -1.02 -0.80 -0.77
34 -0.93 -0.96 -1.01 -1.04 -1.02 -1.11 -1.03 -0.85 -0.46 -0.02
33 -0.87 -0.91 -1.05 -1.02 -1.01 -1.07 -0.85 -0.64 -0.27 -0.05
32 -0.87 -1.02 -0.94 -1.00 -0.93 -0.80 -0.62 -0.48 -0.16 -0.08
31 -0.81 -0.85 -1.02 -0.93 -0.80 -0.82 -0.71 -0.61 -0.46 -0.35
30 -0.79 -0.70 -0.85 -0.70 -0.57 -0.65 -0.66 -0.60 -0.47 -0.48
29 -0.60 -0.81 -0.59 -0.61 -0.62 -0.62 -0.62 -0.56 -0.53 -0.60
28 -0.53 -0.57 -0.66 -0.59 -0.61 -0.58 -0.53 -0.44 -0.54 -0.53
27 -0.65 -0.58 -0.45 -0.37 -0.53 -0.50 -0.55 -0.69 -0.50 -0.50
26 -0.42 -0.56 -0.43 -0.51 -0.58 -0.55 -0.67 -0.69 -0.53 -0.46
25 -0.47 -0.47 -0.48 -0.54 -0.46 -0.56 -0.52 -0.64 -0.60 -0.43
24 -0.48 -0.55 -0.38 -0.61 -0.53 -0.53 -0.53 -0.47 -0.38 -0.33
23 -0.34 -0.54 -0.62 -0.55 -0.40 -0.44 -0.48 -0.50 -0.50 -0.35
22 -0.39 -0.40 -0.44 -0.41 -0.46 -0.58 -0.52 -0.37 -0.44 -0.44
21 -0.38 -0.44 -0.41 -0.53 -0.23 -0.38 -0.49 -0.54 -0.44 -0.39
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 30.—North component surface wind stress for June.

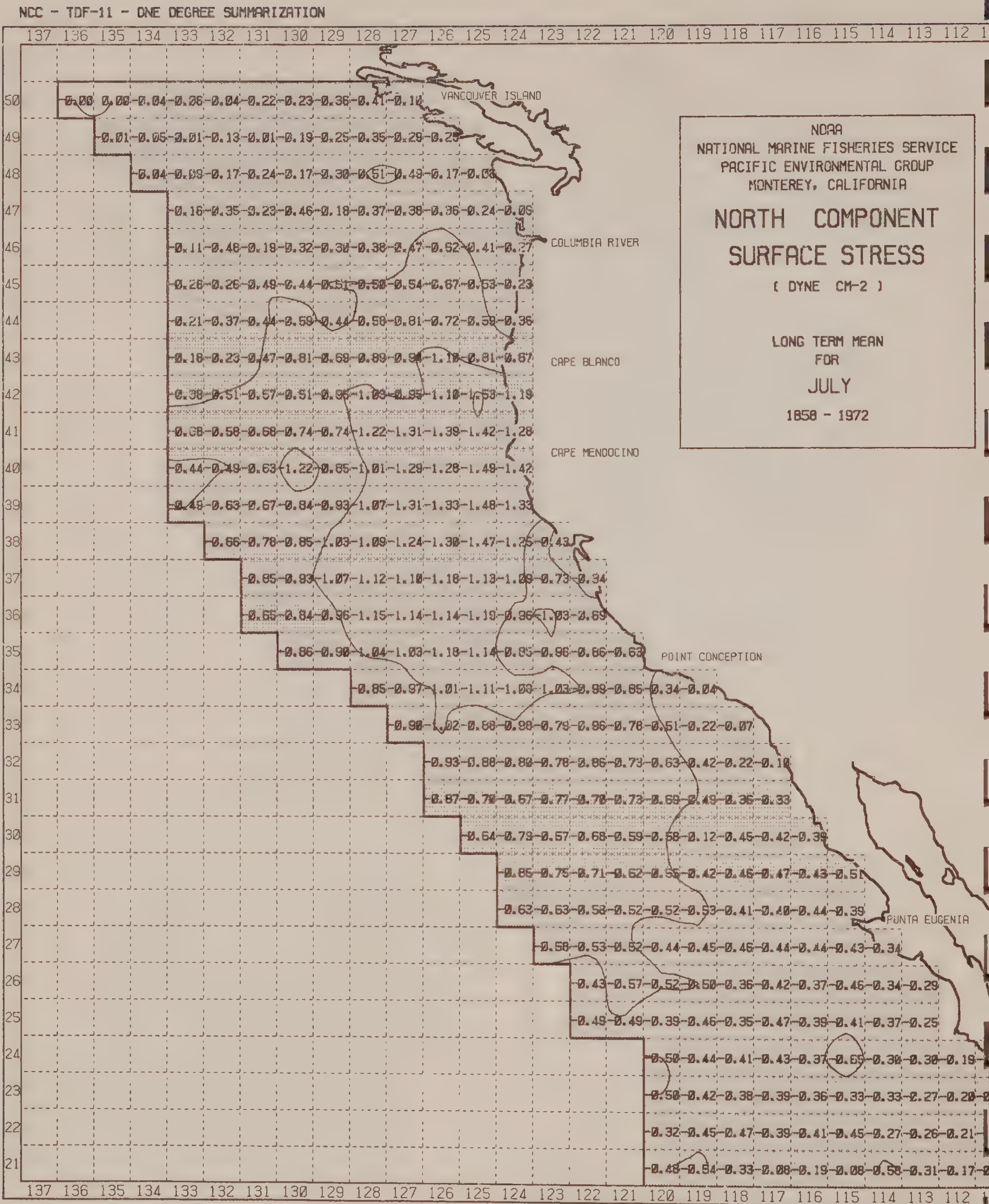

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
JULY
1858 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 -0.00 0.00-0.04-0.06-0.04-0.22-0.23-0.36-0.41-0.10
49 -0.01-0.05-0.01-0.13-0.01-0.19-0.25-0.35-0.28-0.25
48 -0.04-0.09-0.17-0.24-0.17-0.30-0.51-0.48-0.17-0.08
47 -0.16-0.35-0.23-0.46-0.18-0.37-0.38-0.36-0.24-0.06
46 -0.11-0.48-0.19-0.32-0.30-0.38-0.47-0.62-0.41-0.27
45 -0.26-0.26-0.49-0.44-0.51-0.50-0.54-0.67-0.53-0.23
44 -0.21-0.37-0.44-0.59-0.44-0.50-0.81-0.72-0.59-0.36
43 -0.18-0.23-0.47-0.81-0.69-0.89-0.94-1.10-0.81-0.67
42 -0.38-0.51-0.57-0.51-0.95-1.03-0.95-1.10-1.53-1.19
41 -0.68-0.58-0.68-0.74-0.74-1.22-1.31-1.39-1.42-1.28
40 -0.44-0.49-0.63-1.22-0.85-1.01-1.29-1.28-1.49-1.42
39 -0.49-0.63-0.67-0.84-0.93-1.07-1.31-1.33-1.48-1.33
38 -0.66-0.78-0.85-1.03-1.09-1.24-1.30-1.47-1.25-0.43
37 -0.85-0.93-1.07-1.12-1.10-1.18-1.13-1.09-0.73-0.34
36 -0.65-0.84-0.96-1.15-1.14-1.14-1.19-0.96-1.03-0.69
35 -0.86-0.90-1.04-1.03-1.18-1.14-0.85-0.96-0.86-0.63
34 -0.85-0.97-1.01-1.11-1.00-1.03-0.99-0.85-0.34-0.04
33 -0.90-1.02-0.88-0.98-0.79-0.96-0.78-0.51-0.22-0.07
32 -0.93-0.88-0.80-0.78-0.86-0.73-0.63-0.42-0.22-0.10
31 -0.87-0.70-0.67-0.77-0.70-0.73-0.69-0.49-0.36-0.33
30 -0.64-0.79-0.57-0.68-0.59-0.58-0.12-0.45-0.42-0.39
29 -0.85-0.75-0.71-0.62-0.55-0.42-0.46-0.47-0.43-0.51
28 -0.63-0.63-0.58-0.52-0.52-0.53-0.41-0.40-0.44-0.39
27 -0.58-0.53-0.52-0.44-0.45-0.46-0.44-0.44-0.43-0.34
26 -0.43-0.57-0.52-0.50-0.36-0.42-0.37-0.46-0.34-0.29
25 -0.49-0.49-0.39-0.46-0.35-0.47-0.39-0.41-0.37-0.25
24 -0.50-0.44-0.41-0.43-0.37-0.65-0.30-0.30-0.19
23 -0.50-0.42-0.38-0.39-0.36-0.33-0.33-0.27-0.20
22 -0.32-0.45-0.47-0.39-0.41-0.45-0.27-0.26-0.21
21 -0.48-0.54-0.33-0.08-0.19-0.08-0.58-0.31-0.17
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112

Chart 31.—North component surface wind stress for July.

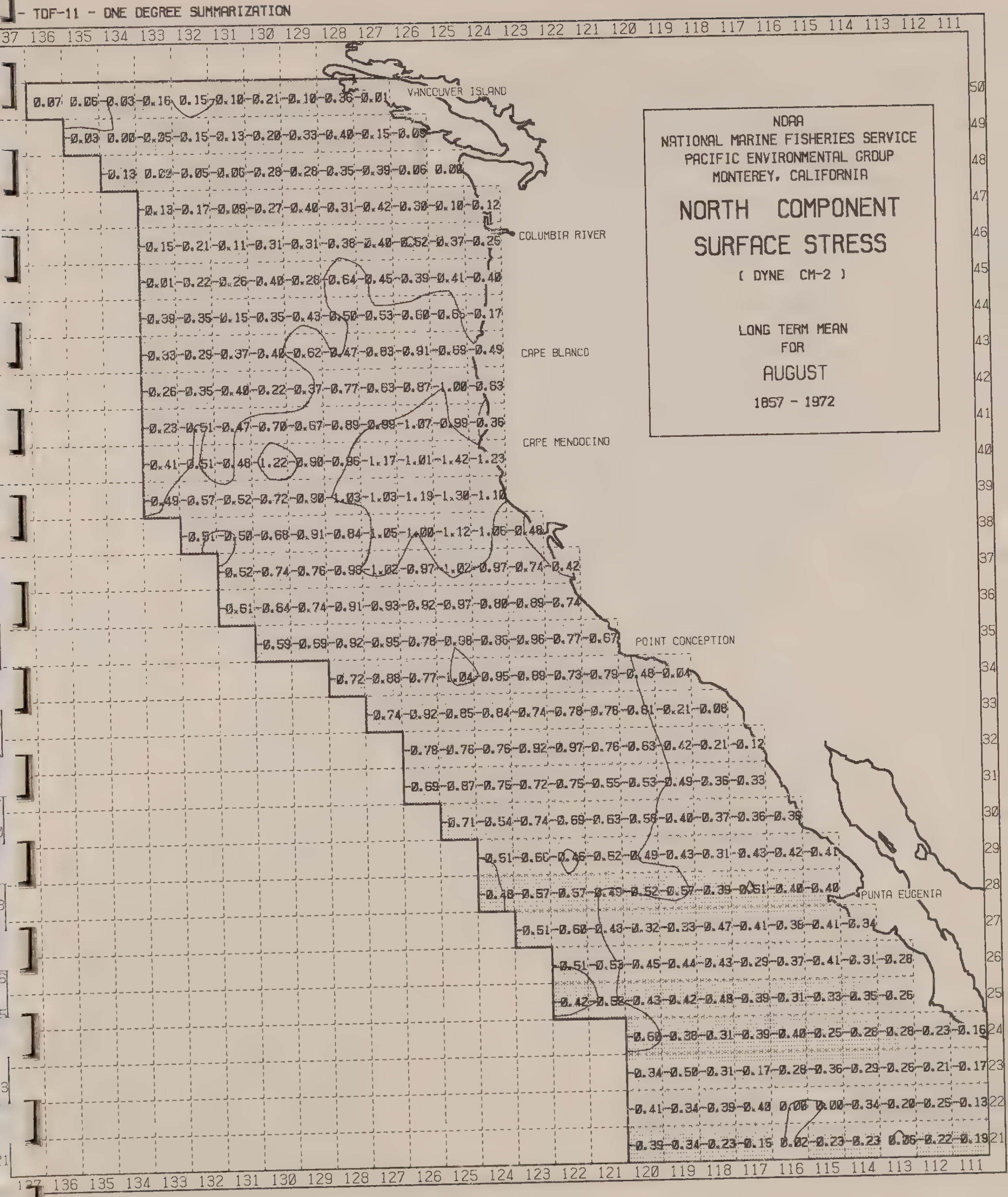

TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
AUGUST
1857 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
0.07 0.06 -0.03 -0.16 0.15 -0.10 -0.21 -0.10 -0.36 -0.01
-0.03 0.00 -0.05 -0.15 -0.13 -0.20 -0.33 -0.40 -0.15 -0.09
-0.13 0.02 -0.05 -0.06 -0.28 -0.28 -0.35 -0.39 -0.06 0.00
-0.13 -0.17 -0.09 -0.27 -0.40 -0.31 -0.42 -0.30 -0.10 -0.12
-0.15 -0.21 -0.11 -0.31 -0.31 -0.38 -0.40 -0.52 -0.37 -0.25
-0.01 -0.22 -0.26 -0.40 -0.28 -0.64 -0.45 -0.39 -0.41 -0.40
-0.39 -0.35 -0.15 -0.35 -0.43 -0.50 -0.53 -0.60 -0.65 -0.17
-0.33 -0.29 -0.37 -0.40 -0.62 -0.47 -0.83 -0.91 -0.69 -0.49
-0.26 -0.35 -0.40 -0.22 -0.37 -0.77 -0.63 -0.87 -1.00 -0.63
-0.23 -0.51 -0.47 -0.70 -0.67 -0.89 -0.99 -1.07 -0.99 -0.36
-0.41 -0.51 -0.48 -1.22 -0.90 -0.96 -1.17 -1.01 -1.42 -1.23
-0.49 -0.57 -0.52 -0.72 -0.90 -1.03 -1.03 -1.19 -1.30 -1.10
-0.51 -0.50 -0.68 -0.91 -0.84 -1.05 -1.00 -1.12 -1.06 -0.48
-0.52 -0.74 -0.76 -0.98 -1.02 -0.97 -1.02 -0.97 -0.74 -0.42
-0.61 -0.64 -0.74 -0.91 -0.93 -0.82 -0.97 -0.80 -0.89 -0.74
-0.59 -0.69 -0.92 -0.95 -0.78 -0.98 -0.86 -0.96 -0.77 -0.67
-0.72 -0.88 -0.77 -1.04 -0.95 -0.89 -0.73 -0.79 -0.48 -0.04
-0.74 -0.92 -0.85 -0.84 -0.74 -0.78 -0.78 -0.81 -0.21 -0.08
-0.78 -0.76 -0.76 -0.92 -0.97 -0.76 -0.63 -0.42 -0.21 -0.12
-0.69 -0.87 -0.75 -0.72 -0.75 -0.55 -0.53 -0.49 -0.36 -0.33
-0.71 -0.54 -0.74 -0.69 -0.63 -0.58 -0.40 -0.37 -0.36 -0.39
-0.51 -0.60 -0.46 -0.62 -0.49 -0.43 -0.31 -0.43 -0.42 -0.41
-0.48 -0.57 -0.57 -0.49 -0.52 -0.57 -0.39 -0.51 -0.40 -0.40
-0.51 -0.60 -0.43 -0.32 -0.23 -0.47 -0.41 -0.38 -0.41 -0.34
-0.51 -0.53 -0.45 -0.44 -0.43 -0.29 -0.37 -0.41 -0.31 -0.28
-0.42 -0.58 -0.43 -0.42 -0.48 -0.39 -0.31 -0.33 -0.35 -0.26
-0.60 -0.38 -0.31 -0.39 -0.40 -0.25 -0.28 -0.28 -0.23 -0.16
-0.34 -0.50 -0.31 -0.17 -0.28 -0.36 -0.29 -0.26 -0.21 -0.17
-0.41 -0.34 -0.39 -0.40 0.06 0.00 -0.34 -0.20 -0.25 -0.13
-0.39 -0.34 -0.23 -0.15 0.02 -0.23 -0.23 0.06 -0.22 -0.19

Chart 32.—North component surface wind stress for August.

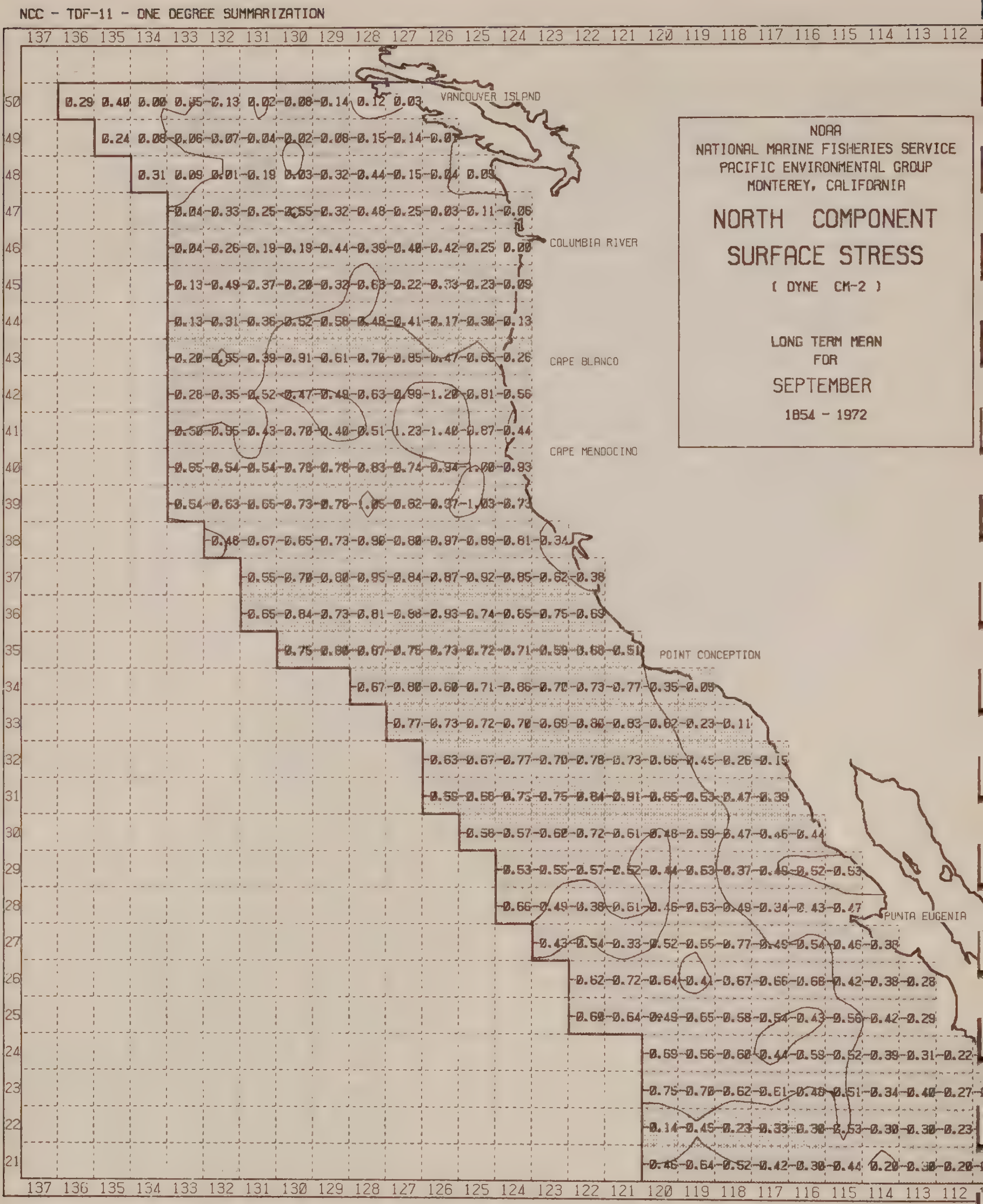

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 0.29 0.40 0.00 0.05 -0.13 0.02 -0.08 -0.14 0.12 0.03
49 0.24 0.08 -0.06 -0.07 -0.04 -0.02 -0.08 -0.15 -0.14 -0.07
48 0.31 0.09 0.01 -0.19 0.03 -0.32 -0.44 -0.15 -0.04 0.09
47 -0.04 -0.33 -0.25 -0.55 -0.32 -0.48 -0.25 -0.03 -0.11 -0.06
46 -0.04 -0.26 -0.19 -0.19 -0.44 -0.39 -0.40 -0.42 -0.25 0.00
45 -0.13 -0.49 -0.37 -0.20 -0.32 -0.68 -0.22 -0.33 -0.23 -0.09
44 -0.13 -0.31 -0.36 -0.52 -0.58 -0.48 -0.41 -0.17 -0.30 -0.13
43 -0.20 -0.55 -0.39 -0.91 -0.61 -0.70 -0.85 -0.47 -0.65 -0.26
42 -0.28 -0.35 -0.52 -0.47 -0.49 -0.63 -0.99 -1.20 -0.81 -0.56
41 -0.50 -0.95 -0.43 -0.70 -0.40 -0.51 -1.23 -1.40 -0.87 -0.44
40 -0.65 -0.54 -0.54 -0.78 -0.78 -0.83 -0.74 -0.94 -1.00 -0.93
39 -0.54 -0.63 -0.65 -0.73 -0.78 -1.05 -0.82 -0.97 -1.03 -0.73
38 -0.48 -0.67 -0.65 -0.73 -0.90 -0.80 -0.97 -0.89 -0.81 -0.34
37 -0.55 -0.70 -0.80 -0.95 -0.84 -0.87 -0.92 -0.85 -0.62 -0.38
36 -0.65 -0.84 -0.73 -0.81 -0.88 -0.93 -0.74 -0.65 -0.75 -0.69
35 -0.75 -0.80 -0.87 -0.76 -0.73 -0.72 -0.71 -0.59 -0.68 -0.51
34 -0.67 -0.80 -0.60 -0.71 -0.86 -0.70 -0.73 -0.77 -0.35 -0.09
33 -0.77 -0.73 -0.72 -0.70 -0.69 -0.80 -0.83 -0.82 -0.23 -0.11
32 -0.63 -0.67 -0.77 -0.70 -0.78 -0.73 -0.66 -0.45 -0.26 -0.15
31 -0.59 -0.68 -0.75 -0.75 -0.84 -0.91 -0.65 -0.53 -0.47 -0.39
30 -0.58 -0.57 -0.60 -0.72 -0.61 -0.48 -0.59 -0.47 -0.46 -0.44
29 -0.53 -0.55 -0.57 -0.52 -0.44 -0.63 -0.37 -0.49 -0.52 -0.53
28 -0.66 -0.49 -0.38 -0.61 -0.46 -0.63 -0.49 -0.34 -0.43 -0.47
27 -0.43 -0.54 -0.33 -0.52 -0.55 -0.77 -0.49 -0.54 -0.46 -0.38
26 -0.62 -0.72 -0.64 -0.41 -0.67 -0.66 -0.68 -0.42 -0.38 -0.28
25 -0.69 -0.64 -0.49 -0.65 -0.58 -0.54 -0.43 -0.56 -0.42 -0.29
24 -0.69 -0.56 -0.60 -0.44 -0.59 -0.52 -0.39 -0.31 -0.22
23 -0.75 -0.70 -0.62 -0.61 -0.40 -0.51 -0.34 -0.40 -0.27
22 -0.14 -0.45 -0.23 -0.33 -0.30 -0.53 -0.30 -0.30 -0.23
21 -0.46 -0.64 -0.52 -0.42 -0.30 -0.44 0.20 -0.30 -0.20
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
SEPTEMBER
1854 - 1972

Chart 33.—North component surface wind stress for September.

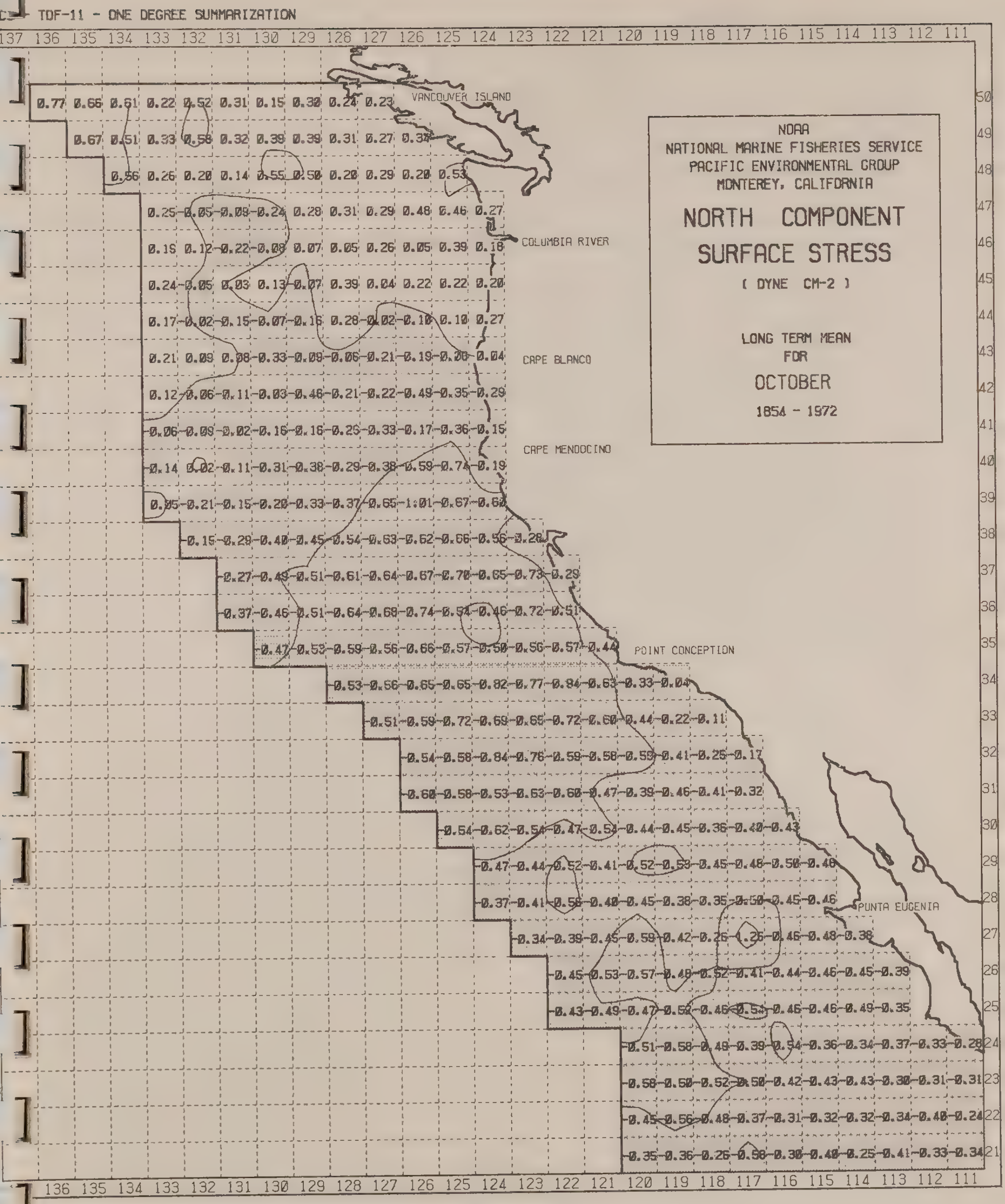

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
OCTOBER
1854 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.77 0.66 0.61 0.22 0.52 0.31 0.15 0.30 0.24 0.23
49 0.67 0.51 0.33 0.58 0.32 0.39 0.39 0.31 0.27 0.37
48 0.56 0.26 0.20 0.14 0.55 0.50 0.20 0.29 0.20 0.53
47 0.25 -0.05 -0.08 -0.24 0.28 0.31 0.29 0.48 0.46 0.27
46 0.19 0.12 -0.22 -0.08 0.07 0.05 0.26 0.05 0.39 0.18
45 0.24 -0.05 0.03 0.13 -0.07 0.39 0.04 0.22 0.22 0.20
44 0.17 -0.02 -0.15 -0.07 -0.16 0.28 -0.02 -0.10 0.10 0.27
43 0.21 0.09 0.08 -0.33 -0.09 -0.06 -0.21 -0.19 -0.20 -0.04
42 0.12 -0.06 -0.11 -0.03 -0.46 -0.21 -0.22 -0.49 -0.35 -0.29
41 -0.06 -0.09 -0.02 -0.16 -0.16 -0.25 -0.33 -0.17 -0.36 -0.15
40 -0.14 0.02 -0.11 -0.31 -0.38 -0.29 -0.38 -0.59 -0.74 -0.19
39 0.05 -0.21 -0.15 -0.20 -0.33 -0.37 -0.65 -1.01 -0.67 -0.62
38 -0.15 -0.29 -0.40 -0.45 -0.54 -0.63 -0.62 -0.66 -0.56 -0.26
37 -0.27 -0.49 -0.51 -0.61 -0.64 -0.67 -0.70 -0.65 -0.73 -0.29
36 -0.37 -0.46 -0.51 -0.64 -0.68 -0.74 -0.54 -0.46 -0.72 -0.51
35 -0.47 -0.53 -0.59 -0.56 -0.66 -0.57 -0.50 -0.56 -0.57 -0.44
34 -0.53 -0.56 -0.65 -0.65 -0.82 -0.77 -0.84 -0.63 -0.33 -0.04
33 -0.51 -0.59 -0.72 -0.69 -0.65 -0.72 -0.60 -0.44 -0.22 -0.11
32 -0.54 -0.58 -0.84 -0.76 -0.59 -0.56 -0.59 -0.41 -0.25 -0.17
31 -0.60 -0.58 -0.53 -0.63 -0.60 -0.47 -0.39 -0.46 -0.41 -0.32
30 -0.54 -0.62 -0.54 -0.47 -0.54 -0.44 -0.45 -0.36 -0.40 -0.43
29 -0.47 -0.44 -0.52 -0.41 -0.52 -0.53 -0.45 -0.48 -0.50 -0.48
28 -0.37 -0.41 -0.56 -0.40 -0.45 -0.38 -0.35 -0.50 -0.45 -0.46
27 -0.34 -0.39 -0.45 -0.59 -0.42 -0.26 -1.26 -0.46 -0.48 -0.38
26 -0.45 -0.53 -0.57 -0.48 -0.52 -0.41 -0.44 -0.46 -0.45 -0.39
25 -0.43 -0.49 -0.47 -0.52 -0.46 -0.54 -0.46 -0.46 -0.49 -0.35
24 -0.51 -0.58 -0.49 -0.39 -0.54 -0.36 -0.34 -0.37 -0.33 -0.28
23 -0.58 -0.50 -0.52 -0.50 -0.42 -0.43 -0.43 -0.30 -0.31 -0.31
22 -0.45 -0.56 -0.48 -0.37 -0.31 -0.32 -0.32 -0.34 -0.40 -0.24
21 -0.35 -0.36 -0.26 -0.58 -0.30 -0.40 -0.25 -0.41 -0.33 -0.34
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 34.—North component surface wind stress for October.

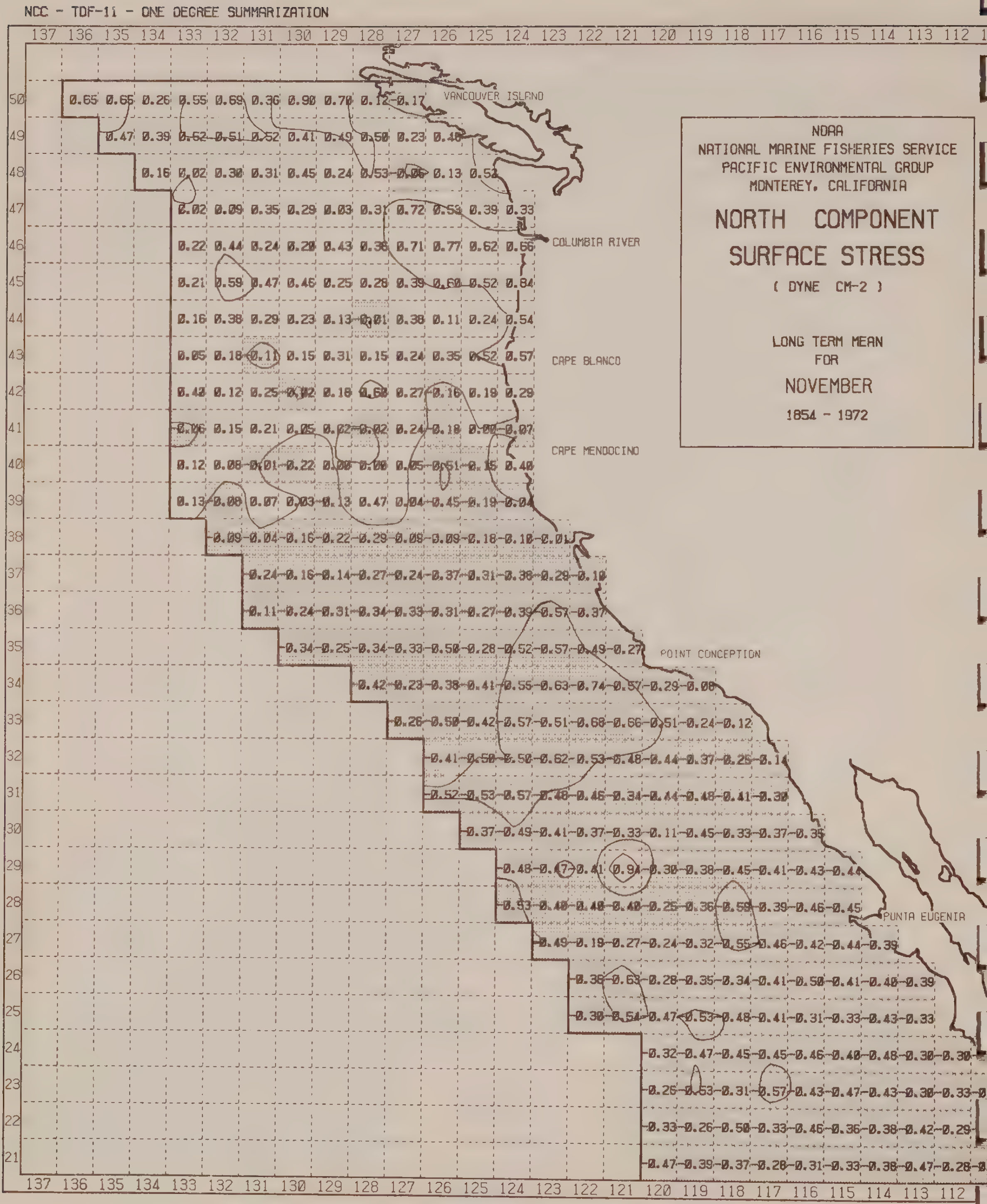

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
NOVEMBER
1854 - 1972
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
50 0.65 0.65 0.26 0.55 0.69 0.36 0.90 0.70 0.12-0.17
49 0.47 0.39 0.52 0.51 0.52 0.41 0.49 0.50 0.23 0.48
48 0.16 0.02 0.30 0.31 0.45 0.24 0.53-0.06 0.13 0.52
47 0.02 0.09 0.35 0.29 0.03 0.31 0.72 0.53 0.39 0.33
46 0.22 0.44 0.24 0.20 0.43 0.36 0.71 0.77 0.62 0.66
45 0.21 0.59 0.47 0.46 0.25 0.28 0.39 0.60 0.52 0.84
44 0.16 0.38 0.29 0.23 0.13-0.01 0.38 0.11 0.24 0.54
43 0.05 0.18-0.11 0.15 0.31 0.15 0.24 0.35 0.52 0.57
42 0.42 0.12 0.25-0.02 0.18 0.68 0.27-0.16 0.19 0.29
41 -0.06 0.15 0.21 0.05 0.02-0.02 0.24-0.18 0.00-0.07
40 0.12 0.08-0.01-0.22 0.00 0.00 0.05-0.51-0.15 0.40
39 0.13-0.08 0.07 0.03-0.13 0.47 0.04-0.45-0.19-0.04
38 -0.09-0.04-0.16-0.22-0.29-0.08-0.09-0.18-0.10-0.01
37 -0.24-0.16-0.14-0.27-0.24-0.37-0.31-0.38-0.29-0.10
36 -0.11-0.24-0.31-0.34-0.33-0.31-0.27-0.39-0.57-0.37
35 -0.34-0.25-0.34-0.33-0.50-0.28-0.52-0.57-0.49-0.27
34 -0.42-0.23-0.38-0.41-0.55-0.63-0.74-0.57-0.29-0.08
33 -0.26-0.50-0.42-0.57-0.51-0.68-0.66-0.51-0.24-0.12
32 -0.41-0.50-0.50-0.62-0.53-0.48-0.44-0.37-0.25-0.14
31 -0.52-0.53-0.57-0.48-0.46-0.34-0.44-0.48-0.41-0.30
30 -0.37-0.49-0.41-0.37-0.33-0.11-0.45-0.33-0.37-0.35
29 -0.48-0.47-0.41 0.94-0.30-0.38-0.45-0.41-0.43-0.44
28 -0.53-0.40-0.40-0.40-0.25-0.36-0.59-0.39-0.46-0.45
27 -0.49-0.19-0.27-0.24-0.32-0.55-0.46-0.42-0.44-0.39
26 -0.36-0.63-0.28-0.35-0.34-0.41-0.50-0.41-0.40-0.39
25 -0.30-0.54-0.47-0.53-0.48-0.41-0.31-0.33-0.43-0.33
24 -0.32-0.47-0.45-0.45-0.46-0.40-0.48-0.30-0.30
23 -0.26-0.53-0.31-0.57-0.43-0.47-0.43-0.30-0.33
22 -0.33-0.26-0.50-0.33-0.46-0.36-0.38-0.42-0.29
21 -0.47-0.39-0.37-0.28-0.31-0.33-0.38-0.47-0.28
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112

Chart 35.—North component surface wind stress for November.

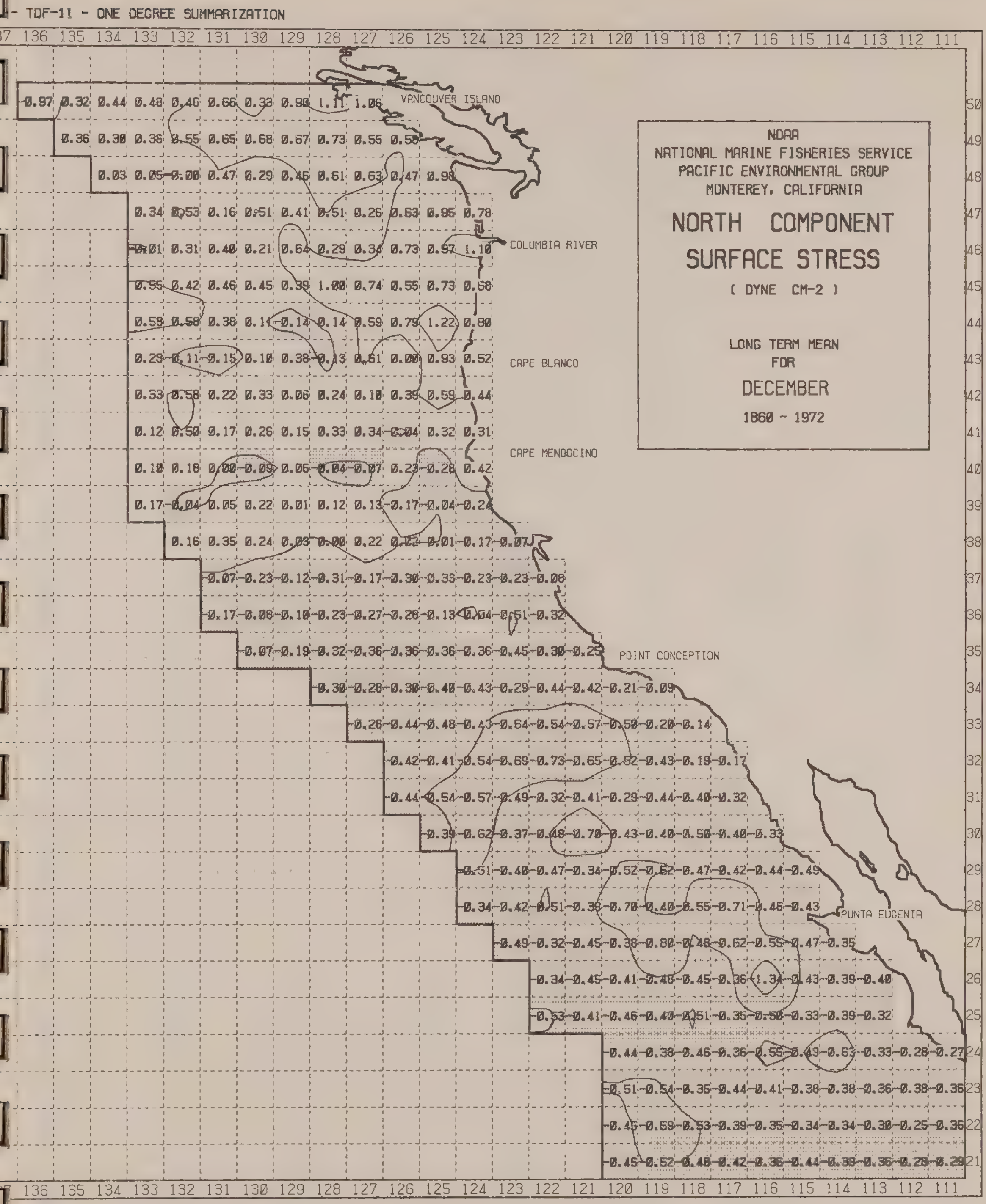

- TDF-11 - ONE DEGREE SUMMARIZATION
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
NORTH COMPONENT
SURFACE STRESS
(DYNE CM-2)
LONG TERM MEAN
FOR
DECEMBER
1860 - 1972
-0.97 0.32 0.44 0.48 0.46 0.66 0.33 0.90 1.11 1.06
0.36 0.30 0.36 0.55 0.65 0.68 0.67 0.73 0.55 0.58
0.03 0.05 -0.00 0.47 0.29 0.46 0.61 0.63 0.47 0.98
0.34 0.53 0.16 0.51 0.41 0.51 0.26 0.63 0.95 0.78
-0.01 0.31 0.40 0.21 0.64 0.29 0.34 0.73 0.97 1.10
0.55 0.42 0.46 0.45 0.39 1.00 0.74 0.55 0.73 0.68
0.58 0.58 0.38 0.11 -0.14 0.14 0.59 0.79 1.22 0.80
0.29 -0.11 -0.15 0.10 0.38 -0.13 0.61 0.00 0.93 0.52
0.33 0.58 0.22 0.33 0.06 0.24 0.10 0.39 0.59 0.44
0.12 0.50 0.17 0.26 0.15 0.33 0.34 -0.04 0.32 0.31
0.10 0.18 0.00 -0.09 0.06 -0.04 -0.07 0.23 -0.28 0.42
0.17 -0.04 0.05 0.22 0.01 0.12 0.13 -0.17 -0.04 -0.24
0.16 0.35 0.24 0.03 0.00 0.22 0.22 -0.01 -0.17 -0.07
-0.07 -0.23 -0.12 -0.31 -0.17 -0.30 -0.33 -0.23 -0.23 -0.08
-0.17 -0.08 -0.10 -0.23 -0.27 -0.28 -0.13 -0.04 -0.51 -0.32
-0.07 -0.19 -0.32 -0.36 -0.36 -0.36 -0.36 -0.45 -0.30 -0.25
-0.30 -0.28 -0.30 -0.40 -0.43 -0.29 -0.44 -0.42 -0.21 -0.09
-0.26 -0.44 -0.48 -0.43 -0.64 -0.54 -0.57 -0.50 -0.20 -0.14
-0.42 -0.41 -0.54 -0.69 -0.73 -0.65 -0.52 -0.43 -0.19 -0.17
-0.44 -0.54 -0.57 -0.49 -0.32 -0.41 -0.29 -0.44 -0.40 -0.32
-0.39 -0.62 -0.37 -0.48 -0.70 -0.43 -0.40 -0.50 -0.40 -0.33
-0.51 -0.40 -0.47 -0.34 -0.52 -0.52 -0.47 -0.42 -0.44 -0.49
-0.34 -0.42 -0.51 -0.39 -0.70 -0.40 -0.55 -0.71 -0.46 -0.43
-0.49 -0.32 -0.45 -0.38 -0.80 -0.48 -0.62 -0.55 -0.47 -0.35
-0.34 -0.45 -0.41 -0.48 -0.45 -0.36 -1.34 -0.43 -0.39 -0.40
-0.53 -0.41 -0.46 -0.40 -0.51 -0.35 -0.50 -0.33 -0.39 -0.32
-0.44 -0.38 -0.46 -0.36 -0.55 -0.49 -0.63 -0.33 -0.28 -0.27
-0.51 -0.54 -0.35 -0.44 -0.41 -0.38 -0.38 -0.36 -0.38 -0.36
-0.45 -0.59 -0.53 -0.39 -0.35 -0.34 -0.34 -0.30 -0.25 -0.36
-0.45 -0.52 -0.48 -0.42 -0.36 -0.44 -0.39 -0.36 -0.28 -0.29

Chart 36.—North component surface wind stress for December.

APPENDIX II

Standard Errors of the Means

The following tables list the computed standard errors of the monthly means by 1-degree square area for the eastward and northward components of the resultant surface wind stress. The standard errors of the means are defined by Equation (3). Each page contains values for 30 1-degree squares blocked in groups of 10. Within each group of 10, all 1-degree squares are defined by a common latitude. The first set of values corresponds to the 1-degree square immediately adjacent to the coast. The final tabulations refer to the 1-degree square farthest from the coast.

The standard error of the mean is tabulated for each month and square. The latitude and longitude of the center of the 1-degree square is listed at the left. The first two numbers below each month are the standard errors of the means for the eastward and northward components, respectively. The units are dyne cm^{-2}. The last value is the number of observations.

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21 N 111 W	.04 .05 74	.03 .03 71	.03 .04 95	.03 .05 75	.03 .04 88	.04 .04 87	.06 .04 101	.04 .04 85	.08 .06 107	.06 .04 95	.08 .05 81	.02 .03 94
21 N 112 W	.03 .05 51	.02 .03 68	.02 .07 52	.03 .07 48	.04 .06 61	.03 .05 66	.08 .06 57	.11 .07 35	.08 .08 57	.04 .06 45	.04 .04 46	.04 .04 57
21 N 113 W	.04 .06 35	.11 .08 50	.04 .10 38	.04 .09 39	.05 .08 39	.04 .07 39	.05 .06 40	.15 .16 25	.08 .16 33	.04 .10 38	.08 .10 37	.05 .05 58
21 N 114 W	.04 .08 41	.10 .07 39	.04 .08 33	.07 .17 22	.05 .11 24	.08 .10 21	.08 .24 32	.15 .16 18	.35 .28 23	.07 .04 28	.03 .07 32	.05 .08 42
21 N 115 W	.16 .09 29	.09 .10 26	.08 .07 35	.08 .13 18	.05 .06 23	.06 .08 23	.03 .02 31	.05 .08 17	.08 .11 19	.07 .11 20	.03 .08 27	.04 .06 40
21 N 116 W	.15 .12 26	.04 .06 28	.07 .09 32	.09 .14 15	.10 .14 13	.07 .07 14	.08 .12 26	.14 .16 15	.20 .15 18	.08 .06 18	.04 .09 18	.03 .06 25
21 N 117 W	.06 .09 38	.03 .06 26	.07 .09 25	.11 .09 19	.05 .10 12	.05 .09 22	.16 .08 15	.13 .19 21	.14 .10 23	.09 .09 22	.02 .06 24	.04 .07 26
21 N 118 W	.09 .08 34	.10 .05 21	.06 .07 24	.14 .14 18	.08 .12 19	.08 .06 19	.12 .09 22	.19 .24 18	.11 .15 21	.03 .03 38	.05 .08 23	.05 .08 34
21 N 119 W	.09 .08 24	.07 .08 26	.06 .09 30	.11 .11 27	.04 .10 19	.09 .06 27	.16 .13 21	.11 .06 22	.08 .18 30	.04 .05 33	.04 .06 43	.07 .07 37
21 N 120 W	.09 .10 24	.05 .06 34	.06 .05 30	.05 .09 28	.06 .07 38	.06 .05 31	.12 .07 39	.05 .09 34	.07 .07 37	.09 .13 40	.05 .05 40	.08 .06 27
22 N 111 W	.02 .04 128	.03 .03 101	.02 .03 164	.04 .05 122	.02 .03 169	.03 .03 150	.03 .02 143	.03 .03 150	.07 .07 161	.03 .03 160	.02 .02 150	.03 .05 120
22 N 112 W	.02 .04 73	.02 .04 60	.03 .05 78	.06 .06 80	.03 .05 99	.03 .04 117	.02 .03 105	.15 .08 116	.04 .04 110	.04 .04 100	.02 .03 90	.03 .05 69
22 N 113 W	.03 .04 51	.04 .11 47	.03 .06 67	.05 .12 57	.03 .07 67	.03 .05 75	.03 .03 84	.04 .05 68	.09 .11 70	.03 .04 73	.03 .05 77	.06 .04 57
22 N 114 W	.03 .06 34	.04 .09 42	.04 .09 45	.02 .07 52	.05 .08 53	.03 .07 50	.04 .04 61	.09 .07 35	.11 .10 58	.03 .08 45	.04 .05 38	.03 .04 66
22 N 115 W	.07 .09 37	.10 .10 30	.06 .09 54	.04 .10 38	.05 .09 36	.03 .09 37	.05 .07 32	.19 .18 34	.09 .07 31	.07 .07 34	.04 .07 22	.07 .06 30
22 N 116 W	.06 .10 24	.05 .10 30	.04 .12 32	.11 .19 15	.05 .11 32	.08 .09 30	.03 .07 26	.32 .29 17	.26 .29 24	.08 .06 21	.04 .07 32	.07 .06 33
22 N 117 W	.05 .11 33	.05 .09 29	.08 .10 34	.05 .11 23	.07 .14 19	.08 .12 15	.07 .10 21	.13 .27 17	.12 .10 17	.05 .06 25	.06 .07 26	.05 .05 27
22 N 118 W	.06 .09 28	.11 .11 27	.04 .06 33	.10 .13 21	.08 .11 17	.06 .12 18	.15 .14 15	.05 .12 17	.21 .17 17	.05 .07 19	.06 .09 23	.05 .07 34
22 N 119 W	.07 .08 31	.07 .27 24	.08 .08 24	.07 .05 25	.10 .10 19	.04 .06 24	.06 .12 19	.12 .10 26	.19 .18 21	.10 .07 21	.12 .07 26	.05 .09 32
22 N 120 W	.07 .08 33	.08 .10 26	.07 .06 31	.09 .08 23	.04 .07 38	.17 .14 17	.08 .10 20	.14 .13 19	.11 .14 22	.07 .07 23	.06 .06 34	.07 .08 20
23 N 111 W	.01 .01 1059	.01 .01 1030	.01 .01 1125	.01 .01 1159	.01 .01 1241	.01 .01 1128	.01 0.00 1178	.02 .03 1152	.01 .01 1132	.01 .01 1199	.01 .01 1083	.03 .01 986
23 N 112 W	.02 .02 155	.02 .03 124	.02 .03 146	.03 .04 135	.03 .03 192	.02 .03 245	.02 .01 203	.04 .03 181	.03 .03 206	.02 .02 187	.02 .03 154	.03 .05 140
23 N 113 W	.03 .09 47	.03 .04 48	.06 .06 47	.03 .06 54	.03 .05 78	.05 .05 78	.02 .03 76	.04 .05 72	.04 .10 79	.03 .04 75	.02 .04 70	.06 .11 47
23 N 114 W	.04 .04 45	.02 .05 44	.04 .08 49	.05 .13 59	.03 .06 79	.03 .05 71	.02 .03 84	.04 .04 96	.05 .06 74	.04 .06 73	.03 .05 59	.06 .09 47
23 N 115 W	.11 .04 42	.03 .07 45	.04 .06 55	.03 .06 67	.03 .09 65	.02 .05 71	.03 .04 62	.05 .05 52	.04 .06 71	.04 .04 68	.05 .05 55	.05 .07 57
23 N 116 W	.04 .07 42	.07 .09 37	.04 .06 48	.05 .07 46	.03 .07 63	.05 .06 46	.03 .05 62	.07 .04 50	.05 .08 51	.04 .06 47	.05 .06 45	.06 .05 54
23 N 117 W	.09 .10 30	.04 .11 34	.06 .07 60	.05 .12 38	.06 .09 48	.04 .07 46	.04 .05 43	.16 .19 28	.09 .09 40	.06 .08 38	.09 .10 33	.05 .04 52
23 N 118 W	.05 .08 34	.10 .10 29	.03 .08 37	.05 .10 33	.06 .08 36	.06 .10 27	.05 .06 32	.16 .16 22	.11 .11 29	.06 .06 32	.06 .06 26	.04 .05 38
23 N 119 W	.06 .08 35	.05 .09 38	.03 .09 38	.06 .09 33	.05 .07 38	.06 .08 39	.06 .08 30	.07 .12 16	.10 .11 24	.07 .09 26	.17 .10 24	.10 .08 37
23 N 120 W	.10 .10 37	.05 .06 30	.06 .10 21	.11 .14 17	.04 .06 22	.05 .09 23	.08 .17 17	.08 .09 22	.07 .10 24	[illegible] [illegible] [illegible]	.14 .08 32	.06 .08 42

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
24 N	.01	.01	.01	.01	.02	.01	.01	.01	.03	.01	.01	.01
111 W	.01	.01	.01	.01	.01	.01	.01	.01	.06	.01	.01	.01
	572	494	590	587	591	603	596	602	566	535	594	504
24 N	0.00	.01	.02	.01	.01	.01	.01	.01	.01	0.00	0.00	.01
112 W	.01	.01	.01	.01	.01	.01	0.00	.01	.01	.01	.01	.01
	1226	1209	1375	1380	1458	1398	1453	1324	1382	1379	1336	1208
24 N	.02	.03	.03	.03	.02	.02	.02	.02	.03	.03	.02	.02
113 W	.04	.04	.03	.05	.03	.03	.02	.02	.03	.03	.02	.03
	143	142	195	150	176	210	193	223	214	177	172	141
24 N	.07	.06	.05	.05	.04	.04	.03	.04	.05	.04	.05	.14
114 W	.06	.09	.08	.07	.05	.05	.05	.06	.06	.05	.08	.18
	42	39	45	38	58	54	54	70	78	62	44	25
24 N	.07	.05	.05	.07	.04	.07	.03	.04	.05	.05	.03	.07
115 W	.09	.08	.08	.15	.07	.10	.06	.05	.06	.05	.07	.10
	29	31	39	46	59	49	87	51	68	56	44	22
24 N	.05	.03	.08	.04	.04	.05	.02	.06	.04	.03	.02	.04
116 W	.07	.06	.09	.08	.08	.06	.04	.05	.08	.05	.06	.10
	35	43	37	55	67	68	75	73	56	59	56	39
24 N	.05	.06	.04	.06	.04	.03	.03	.04	.04	.03	.04	.04
117 W	.07	.15	.09	.18	.08	.07	.06	.05	.06	.05	.05	.05
	43	29	33	44	62	71	71	62	60	56	51	57
24 N	.05	.06	.04	.05	.05	.03	.02	.09	.05	.04	.04	.07
118 W	.06	.08	.06	.09	.08	.06	.06	.06	.08	.05	.06	.06
	35	47	49	40	52	52	47	44	50	57	48	39
24 N	.03	.11	.08	.05	.04	.03	.06	.13	.05	.04	.08	.04
119 W	.05	.13	.07	.10	.07	.09	.08	.08	.09	.07	.08	.04
	40	41	56	44	57	39	53	38	36	40	36	50
24 N	.07	.04	.03	.05	.05	.05	.08	.15	.08	.07	.05	.05
120 W	.08	.07	.08	.08	.06	.09	.05	.10	.11	.05	.06	.06
	47	55	57	45	41	30	38	29	35	38	46	48
25 N	0.00	.01	.01	.01	.01	.01	.01	0.00	.01	0.00	0.00	.01
113 W	.01	.01	.01	.01	.01	.01	0.00	.01	.01	.01	.01	.01
	1297	1257	1441	1409	1509	1467	1508	1431	1431	1426	1408	1269
25 N	.02	.02	.04	.03	.03	.03	.04	.02	.03	.13	.03	.03
114 W	.04	.04	.05	.05	.04	.03	.04	.02	.04	.06	.04	.03
	147	128	139	150	176	206	177	225	200	185	149	125
25 N	.56	.04	.05	.03	.03	.05	.03	.04	.03	.02	.05	.08
115 W	.65	.09	.08	.08	.07	.08	.04	.04	.06	.04	.05	.09
	31	32	42	59	86	66	81	73	67	66	46	30
25 N	.10	.08	.12	.05	.08	.06	.03	.02	.14	.04	.05	.10
116 W	.17	.06	.13	.12	.08	.09	.05	.03	.08	.11	.06	.16
	15	22	27	23	35	31	46	53	44	25	37	14
25 N	.04	.11	.10	.04	.04	.05	.03	.06	.06	.05	.05	.11
117 W	.07	.10	.12	.09	.06	.06	.05	.06	.08	.07	.08	.16
	23	27	30	35	52	40	51	59	38	45	34	22
25 N	.06	.04	.06	.05	.04	.04	.02	.05	.06	.02	.05	.03
118 W	.06	.10	.10	.20	.08	.06	.05	.07	.10	.05	.08	.08
	33	29	34	41	61	58	67	57	48	61	42	50
25 N	.06	.06	.05	.05	.05	.04	.03	.03	.04	.03	.05	.05
119 W	.08	.10	.07	.14	.08	.07	.07	.05	.09	.05	.11	.06
	52	34	50	42	54	70	58	59	56	58	49	48
25 N	.07	.07	.04	.04	.04	.03	.02	.04	.04	.04	.04	.07
120 W	.09	.12	.06	.08	.07	.05	.04	.06	.07	.06	.09	.08
	37	36	49	52	61	44	55	51	41	45	54	36
25 N	.07	.05	.03	.05	.04	.04	.03	.08	.08	.05	.09	.07
121 W	.06	.10	.06	.07	.06	.06	.06	.08	.08	.05	.15	.07
	46	42	53	38	49	41	55	46	41	60	33	37
25 N	.05	.07	.04	.06	.02	.04	.04	.06	.06	.05	.10	.09
122 W	.08	.08	.06	.08	.05	.05	.06	.06	.09	.06	.06	.06
	50	52	56	59	68	36	44	45	48	54	49	56
26 N	.01	.01	.02	.02	.02	.01	.01	.01	.02	.01	.01	.02
113 W	.02	.02	.02	.02	.02	.02	.06	.01	.02	.02	.02	.02
	372	399	424	397	444	452	398	408	428	427	439	389
26 N	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.01	.01
114 W	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.01	.01
	1199	1201	1438	1327	1367	1334	1360	1346	1331	1333	1253	1165
26 N	.04	.03	.04	.03	.04	.02	.02	.02	.03	.03	.02	.03
115 W	.04	.04	.05	.05	.04	.04	.03	.03	.05	.04	.04	.05
	120	115	126	117	135	158	148	150	147	129	129	96
26 N	.08	.07	.08	.06	.04	.04	.03	.03	.04	.03	.05	.15
116 W	.09	.14	.10	.10	.07	.07	.04	.05	.07	.05	.08	.80
	30	24	34	45	65	68	68	59	66	55	60	30
26 N	.07	.12	.24	.04	.03	.03	.04	.05	.04	.03	.04	.20
117 W	.16	.18	.28	.09	.07	.09	.05	.08	.09	.06	.05	.19
	16	15	16	33	30	37	59	48	42	35	30	16
26 N	.04	.06	.12	.04	.04	.04	.04	.05	.04	.04	.05	.10
118 W	.09	.09	.12	.15	.08	.07	.05	.06	.07	.07	.10	.14
	32	24	32	26	35	34	35	43	52	39	25	13
26 N	.05	.10	.06	.05	.04	.04	.03	.02	.06	.05	.04	.04
119 W	.09	.11	.09	.14	.08	.08	.06	.08	.10	.07	.07	.09
	33	29	26	33	41	36	43	38	24	30	37	27
26 N	.10	.10	.09	.11	.03	.02	.05	.03	.06	.03	.06	.05
120 W	.07	.15	.15	.09	.08	.05	.08	.06	.09	.06	.06	.09
	30	24	34	38	57	59	50	45	48	57	43	38
26 N	.05	.10	.04	.04	.04	.03	.08	.03	.04	.04	.05	.07
121 W	.07	.12	.10	.09	.09	.06	.08	.05	.09	.05	.14	.08
	59	26	40	54	55	69	43	66	47	51	42	46
26 N	.05	.04	.06	.03	.03	.02	.03	.03	.03	.03	.03	.08
122 W	.06	.06	.06	.09	.07	.04	.05	.05	.06	.04	.05	.07
	37	52	61	54	55	57	60	57	60	63	70	50

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
27 N	.02	.02	.02	.02	.02	.02	.01	.01	.02	.01	.02	.02
114 W	.02	.02	.02	.02	.02	.02	.01	.01	.02	.01	.02	.02
	468	458	542	517	548	488	527	452	549	524	511	521
27 N	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
115 W	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02
	1113	1085	1245	1204	1250	1194	1209	1188	1169	1183	1122	973
27 N	.06	.04	.02	.03	.04	.04	.02	.02	.03	.03	.03	.04
116 W	.07	.06	.10	.04	.05	.05	.04	.03	.06	.06	.05	.07
	76	102	88	108	101	110	99	120	130	84	86	62
27 N	.08	.05	.08	.05	.05	.03	.03	.03	.03	.43	.06	.06
117 W	.12	.07	.10	.11	.08	.06	.06	.06	.05	.73	.07	.10
	29	34	43	48	51	64	71	71	76	55	51	25
27 N	.06	.07	.10	.05	.04	.03	.02	.03	.04	.03	.05	.24
118 W	.10	.16	.14	.11	.08	.06	.05	.04	.08	.04	.09	.10
	28	20	23	32	36	43	70	53	49	31	37	19
27 N	.03	.10	.11	.06	.04	.04	.03	.04	.04	.03	.04	.04
119 W	.09	.32	.08	.09	.10	.10	.10	.05	.07	.06	.05	.22
	19	12	16	34	32	32	29	32	37	37	26	20
27 N	.07	.11	.08	.05	.03	.03	.04	.04	.08	.04	.09	.06
120 W	.11	.27	.11	.11	.14	.08	.07	.07	.09	.09	.14	.08
	34	19	23	20	30	33	29	38	36	26	17	15
27 N	.13	.06	.11	.05	.04	.05	.04	.03	.06	.04	.07	.08
121 W	.09	.05	.12	.12	.08	.10	.12	.05	.13	.07	.07	.14
	40	25	29	42	46	18	31	49	24	49	33	17
27 N	.07	.09	.06	.03	.05	.05	.05	.04	.06	.02	.07	.07
122 W	.06	.12	.11	.10	.08	.06	.09	.08	.09	.05	.08	.05
	36	33	51	53	58	64	54	62	48	75	53	62
27 N	.04	.08	.06	.03	.02	.03	.05	.03	.03	.02	.06	.06
123 W	.07	.09	.09	.07	.05	.06	.08	.05	.04	.04	.08	.09
	69	52	63	75	93	90	60	80	91	105	77	51
28 N	.03	.02	.01	.02	.01	.01	.01	.01	.01	.01	.01	.02
115 W	.06	.02	.02	.03	.02	.01	.01	.01	.02	.01	.02	.02
	588	517	742	720	723	668	632	685	709	695	676	624
28 N	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02
116 W	.02	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.02
	810	747	866	843	874	903	831	840	835	875	821	735
28 N	.06	.05	.05	.03	.04	.03	.04	.03	.04	.04	.04	.09
117 W	.05	.07	.06	.06	.06	.04	.05	.07	.05	.05	.08	.12
	75	72	65	69	59	69	53	66	75	71	55	56
28 N	.05	.07	.05	.07	.05	.03	.02	.04	.04	.02	.05	.05
118 W	.06	.11	.09	.15	.06	.07	.06	.04	.07	.06	.10	.14
	34	24	25	30	41	47	56	63	54	43	33	22
28 N	.06	.04	.05	.05	.04	.04	.03	.03	.04	.03	.06	.13
119 W	.06	.11	.08	.09	.05	.07	.07	.07	.11	.06	.10	.14
	38	30	33	43	53	72	67	55	39	39	33	19
28 N	.20	.29	.08	.06	.06	.03	.06	.04	.03	.05	.05	.10
120 W	.16	.36	.09	.11	.11	.08	.06	.07	.06	.08	.12	.20
	17	18	36	43	33	39	36	41	45	22	31	20
28 N	.06	.08	.08	.05	.04	.05	.05	.02	.04	.04	.03	.06
121 W	.09	.25	.11	.10	.09	.10	.09	.05	.09	.07	.08	.10
	35	14	28	41	31	41	29	48	32	39	31	23
28 N	.06	.04	.07	.05	.05	.05	.03	.05	.03	.03	.08	.05
122 W	.11	.10	.12	.10	.13	.08	.08	.08	.05	.08	.16	.11
	56	34	45	32	44	44	55	58	43	54	27	35
28 N	.10	.08	.06	.03	.05	.05	.03	.07	.04	.03	.07	.06
123 W	.12	.10	.12	.10	.06	.11	.10	.07	.05	.04	.09	.06
	47	50	44	68	70	37	41	65	65	80	75	58
28 N	.06	.05	.05	.05	.03	.06	.06	.08	.09	.02	.06	.06
124 W	.08	.07	.12	.09	.07	.06	.09	.07	.08	.04	.07	.09
	48	46	43	44	65	54	46	47	38	88	67	51
29 N	.07	.07	.11	.07	.09	.05	.07	.07	.05	.05	.12	.08
115 W	.09	.08	.09	.09	.10	.06	.07	.04	.07	.05	.07	.09
	62	88	90	80	71	66	61	63	59	58	73	67
29 N	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
116 W	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
	1130	1149	1209	1155	1246	1080	1081	1115	1109	1112	1051	983
29 N	.03	.02	.02	.02	.02	.02	.02	.01	.02	.02	.02	.03
117 W	.03	.03	.03	.03	.03	.02	.02	.02	.02	.02	.03	.03
	252	249	336	308	250	294	267	280	273	265	261	229
29 N	.03	.08	.07	.07	.05	.04	.05	.03	.08	.04	.05	.06
118 W	.06	.10	.08	.07	.07	.07	.06	.05	.06	.05	.05	.09
	108	58	71	65	59	64	49	56	54	55	56	37
29 N	.07	.07	.10	.05	.05	.04	.03	.05	.04	.02	.10	.05
119 W	.09	.09	.22	.08	.10	.09	.07	.10	.09	.05	.09	.07
	27	21	34	35	43	45	43	33	42	54	33	35
29 N	.06	.07	.10	.05	.04	.04	.05	.03	.04	.06	.06	.06
120 W	.11	.09	.15	.09	.07	.08	.07	.05	.08	.09	.09	.11
	29	28	25	56	48	44	52	68	55	36	27	36
29 N	.05	.11	.09	.05	.05	.03	.04	.03	.07	.04	.46	.08
121 W	.08	.12	.12	.08	.08	.07	.08	.07	.07	.08	1.27	.09
	59	29	42	50	51	69	59	54	45	44	42	34
29 N	.05	.09	.07	.04	.05	.03	.04	.03	.05	.03	.07	.08
122 W	.10	.13	.13	.10	.06	.06	.09	.06	.06	.06	.07	.08
	73	48	51	56	81	84	52	86	44	82	62	39
29 N	.08	.05	.09	.05	.04	.03	.03	.16	.02	.03	.07	.06
123 W	.12	.13	.11	.12	.07	.08	.06	.07	.05	.06	.09	.09
	63	39	39	45	65	61	65	61	73	68	54	58
29 N	.06	.07	.07	.05	.03	.04	.04	.02	.06	.04	.07	.08
124 W	.11	.07	.14	.08	.07	.07	.10	.05	.05	.06	.08	.11
	51	50	36	50	76	54	54	57	53	80	89	31

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
30 N 116 W	.02 .02 571	.02 .02 506	.02 .03 637	.01 .02 581	.01 .02 624	.01 .02 593	.01 .01 547	.01 .01 537	.01 .02 553	.01 .02 557	.01 .02 545	.01 .02 481
30 N 117 W	.01 .02 504	.01 .02 630	.01 .02 698	.01 .02 668	.05 .04 658	.01 .01 654	.01 .01 666	.01 .01 693	.01 .02 651	.01 .01 672	.03 .04 645	.02 .02 591
30 N 118 W	.04 .05 194	.02 .03 209	.03 .04 187	.04 .04 201	.03 .04 193	.03 .04 190	.02 .03 195	.02 .02 188	.02 .03 180	.02 .02 203	.03 .03 182	.04 .05 165
30 N 119 W	.07 .08 76	.06 .09 65	.07 .08 60	.04 .05 65	.10 .10 38	.04 .06 73	.02 .03 139	.03 .06 52	.05 .08 60	.06 .05 91	.06 .10 48	.08 .10 42
30 N 120 W	.05 .09 63	.05 .08 113	.08 .10 58	.05 .07 99	.03 .05 86	.05 .06 91	.04 .06 67	.05 .06 70	.04 .05 56	.04 .04 95	.07 .07 37	.06 .10 52
30 N 121 W	.07 .08 71	.06 .07 81	.07 .11 58	.04 .08 107	.03 .07 91	.04 .05 86	.03 .05 84	.03 .05 102	.04 .06 70	.03 .06 89	.04 .08 35	.10 .11 53
30 N 122 W	.05 .07 92	.12 .16 60	.09 .12 47	.08 .11 51	.04 .08 100	.03 .08 104	.03 .06 77	.04 .06 88	.04 .07 73	.05 .06 74	.05 .08 51	.05 .09 49
30 N 123 W	.05 .08 78	.13 .13 50	.12 .15 48	.07 .14 54	.04 .06 87	.03 .07 80	.03 .06 72	.03 .12 73	.06 .09 69	.03 .09 82	.04 .10 69	.03 .05 96
30 N 124 W	.11 .11 66	.09 .11 80	.04 .07 55	.03 .07 75	.04 .07 110	.02 .05 108	.04 .08 60	.05 .07 83	.03 .07 66	.03 .07 113	.04 .09 87	.05 .09 63
30 N 125 W	.08 .12 78	.10 .15 66	.06 .10 57	.05 .10 65	.07 .08 55	.04 .08 78	.04 .08 64	.04 .08 78	.04 .06 70	.03 .07 86	.06 .09 72	.06 .08 65
31 N 117 W	.01 .01 776	.01 .02 793	.01 .01 922	.01 .01 880	.01 .01 916	.01 .01 866	.01 .01 826	.01 .01 837	.01 .01 861	.01 .01 821	.01 .02 793	.01 .02 706
31 N 118 W	.02 .03 394	.03 .03 402	.02 .03 446	.02 .02 442	.02 .03 441	.02 .02 384	.01 .02 360	.01 .01 443	.02 .02 499	.02 .02 441	.02 .02 459	.03 .03 372
31 N 119 W	.02 .03 294	.02 .04 294	.04 .06 236	.04 .04 286	.03 .03 253	.02 .03 296	.02 .03 255	.02 .03 214	.02 .03 267	.02 .02 345	.04 .04 222	.04 .05 154
31 N 120 W	.05 .07 169	.04 .06 143	.05 .07 131	.05 .06 149	.04 .06 144	.03 .05 124	.03 .05 158	.03 .04 126	.04 .06 98	.03 .03 212	.04 .07 122	.03 .06 84
31 N 121 W	.05 .08 163	.04 .08 145	.05 .10 101	.03 .06 131	.06 .06 119	.05 .07 105	.03 .04 132	.04 .05 95	.04 .08 78	.04 .05 131	.04 .06 101	.06 .08 78
31 N 122 W	.04 .06 115	.05 .10 98	.05 .10 97	.08 .11 70	.06 .07 104	.03 .07 104	.03 .05 106	.04 .06 87	.04 .09 79	.03 .08 127	.05 .10 107	.05 .08 87
31 N 123 W	.03 .06 171	.06 .10 110	.06 .08 84	.04 .10 91	.04 .06 109	.03 .07 123	.02 .05 170	.03 .05 142	.03 .06 133	.03 .07 153	.04 .06 111	.05 .10 79
31 N 124 W	.07 .09 112	.07 .12 86	.06 .10 105	.04 .07 173	.02 .04 207	.03 .06 169	.02 .05 166	.02 .06 102	.03 .06 133	.03 .05 146	.05 .08 119	.06 .10 107
31 N 125 W	.06 .08 134	.05 .09 121	.04 .07 139	.06 .08 144	.03 .06 126	.03 .06 150	.02 .04 160	.03 .07 125	.03 .06 124	.03 .08 166	.05 .09 122	.05 .11 92
31 N 126 W	.05 .08 157	.06 .10 137	.06 .07 152	.04 .07 145	.03 .05 149	.03 .05 155	.03 .06 158	.02 .05 145	.02 .04 144	.03 .06 180	.05 .06 148	.05 .09 131
32 N 117 W	.01 .01 1046	.01 .01 912	.01 .01 1055	.01 .01 967	.01 .01 1095	0.00 0.00 1059	0.00 0.00 931	0.00 0.00 1097	.01 .01 1041	.01 .01 1062	.01 .01 887	.01 .01 714
32 N 118 W	.01 .01 2163	.01 .01 1933	.01 .01 2268	.01 .01 2283	.01 0.00 2375	0.00 0.00 2221	.01 0.00 1934	0.00 0.00 2512	.01 0.00 2363	.01 .01 2284	.01 .01 1882	.01 .01 1133
32 N 119 W	.01 .02 1108	.02 .02 981	.02 .02 1244	.01 .02 1106	.01 .01 1140	.01 .01 1000	.01 .01 1054	.02 .01 1128	.01 .01 1220	.01 .01 1399	.02 .02 1017	.02 .02 768
32 N 120 W	.02 .03 451	.03 .05 350	.03 .03 491	.03 .04 479	.03 .03 465	.03 .04 354	.02 .02 500	.02 .02 433	.02 .02 573	.02 .03 492	.02 .03 419	.04 .05 262
32 N 121 W	.03 .06 241	.04 .06 252	.04 .07 235	.04 .05 249	.03 .05 254	.04 .05 196	.02 .04 272	.03 .04 225	.03 .04 245	.02 .04 293	.05 .06 233	.05 .07 189
32 N 122 W	.04 .07 198	.05 .08 214	.04 .08 212	.06 .08 214	.04 .06 188	.03 .06 190	.03 .05 229	.04 .06 171	.03 .05 191	.03 .04 302	.03 .05 208	.05 .08 176
32 N 123 W	.03 .06 287	.05 .08 197	.04 .07 218	.05 .08 198	.04 .07 190	.03 .07 172	.02 .04 203	.03 .05 188	.03 .05 181	.03 .06 253	.03 .06 232	.04 .08 184
32 N 124 W	.01 .04 771	.02 .04 531	.02 .03 630	.03 .05 432	.01 .04 569	.01 .03 551	.01 .02 662	.01 .02 711	.01 .02 662	.01 .04 828	.02 .03 623	.01 .03 637
32 N 125 W	.03 .05 302	.03 .06 273	.05 .06 289	.04 .05 267	.04 .05 273	.02 .05 263	.02 .05 268	.02 .04 284	.02 .04 237	.02 .05 353	.02 .04 323	.03 .06 363
32 N 126 W	.03 .05 289	.05 .07 252	.03 .05 307	.03 .05 300	.03 .05 278	.02 .04 257	.02 .05 267	.02 .04 280	.01 .04 247	.02 .05 320	.03 .04 352	.03 .06 311

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
33 N 118 W	0.00 0.00 3638	.01 .01 3329	.01 0.00 3831	.01 0.00 3776	0.00 0.00 3805	0.00 0.00 3305	0.00 0.00 3107	0.00 0.00 3712	0.00 0.00 3483	0.00 0.00 3798	0.00 0.00 3536	.01 .01 2251
33 N 119 W	.01 .01 1351	.02 .02 1121	.02 .01 1557	.02 .01 1412	.02 .01 1492	.01 .01 1320	.01 .01 1079	.01 0.00 1595	.01 .01 1476	.01 .01 1686	.01 .01 1461	.02 .01 1023
33 N 120 W	.02 .02 966	.03 .04 610	.02 .02 930	.03 .02 935	.02 .02 1064	.02 .02 1124	.02 .02 823	.01 .02 967	.01 .02 1000	.01 .02 975	.02 .02 934	.03 .03 699
33 N 121 W	.02 .04 473	.03 .06 289	.04 .06 392	.04 .05 333	.05 .06 410	.03 .04 415	.03 .05 303	.02 .03 341	.03 .04 384	.03 .04 310	.03 .05 341	.03 .05 293
33 N 122 W	.03 .06 345	.04 .07 305	.04 .06 372	.04 .06 350	.03 .04 332	.04 .06 276	.04 .05 306	.02 .04 269	.02 .04 298	.03 .06 297	.03 .05 347	.03 .05 332
33 N 123 W	.03 .06 363	.03 .06 313	.04 .06 336	.02 .04 575	.02 .05 462	.03 .05 329	.02 .03 411	.02 .04 286	.02 .04 308	.02 .04 310	.03 .05 345	.03 .05 362
33 N 124 W	.02 .05 400	.03 .06 286	.03 .05 395	.04 .06 313	.02 .05 389	.03 .05 319	.02 .05 314	.01 .03 378	.02 .04 287	.02 .05 406	.03 .05 377	.03 .05 377
33 N 125 W	.03 .05 356	.03 .06 318	.03 .06 330	.03 .06 272	.02 .05 324	.03 .05 285	.02 .04 273	.01 .04 306	.02 .05 238	.02 .05 329	.03 .04 339	.03 .06 356
33 N 126 W	.06 .07 244	.04 .08 187	.04 .08 217	.04 .08 185	.02 .05 217	.03 .06 164	.02 .06 204	.03 .06 187	.02 .05 182	.02 .06 216	.03 .06 221	.03 .06 256
33 N 127 W	.05 .08 196	.05 .09 178	.04 .07 199	.07 .08 154	.03 .07 164	.04 .06 152	.03 .06 178	.03 .06 137	.03 .07 143	.03 .06 182	.05 .06 183	.06 .11 199
34 N 119 W	.01 .01 1505	.01 .01 1637	.01 0.00 1774	.01 0.00 1990	.01 .01 1924	0.00 0.00 1615	0.00 0.00 1623	0.00 0.00 1420	.01 0.00 1448	.01 0.00 1472	.01 .01 1261	.02 .01 995
34 N 120 W	.02 .02 599	.03 .03 588	.03 .02 743	.03 .03 705	.04 .03 643	.02 .02 721	.02 .02 775	.03 .02 650	.02 .02 656	.02 .02 640	.02 .02 652	.02 .02 769
34 N 121 W	.02 .03 576	.03 .04 506	.03 .04 594	.03 .04 535	.03 .04 543	.02 .03 676	.02 .03 603	.02 .02 650	.02 .03 577	.02 .03 567	.02 .03 558	.03 .04 495
34 N 122 W	.03 .05 276	.04 .07 261	.04 .07 274	.04 .07 239	.04 .06 258	.07 .09 265	.03 .04 284	.03 .04 232	.03 .05 246	.04 .07 228	.04 .08 272	.03 .05 256
34 N 123 W	.04 .07 230	.05 .08 228	.03 .08 258	.04 .07 185	.05 .08 189	.05 .08 190	.04 .06 197	.04 .06 156	.04 .05 172	.03 .07 263	.04 .06 207	.03 .07 212
34 N 124 W	.03 .05 265	.05 .07 204	.04 .07 229	.05 .07 218	.06 .08 147	.04 .07 166	.04 .08 152	.04 .06 146	.03 .13 188	.03 .06 273	.04 .07 206	.04 .07 241
34 N 125 W	.04 .06 229	.05 .08 199	.04 .07 240	.05 .07 204	.05 .08 152	.04 .07 143	.04 .07 149	.07 .07 137	.03 .06 175	.02 .07 234	.03 .05 217	.06 .09 234
34 N 126 W	.07 .08 206	.05 .09 200	.05 .07 204	.06 .09 196	.05 .09 149	.04 .08 132	.03 .07 141	.04 .07 101	.04 .06 142	.03 .06 189	.05 .08 184	.04 .07 232
34 N 127 W	.05 .08 208	.06 .07 182	.06 .07 212	.05 .08 186	.05 .08 138	.04 .07 134	.04 .08 122	.03 .08 96	.03 .08 145	.03 .06 164	.05 .08 187	.05 .06 218
34 N 128 W	.05 .08 230	.06 .08 184	.06 .07 224	.06 .09 182	.04 .07 179	.04 .07 148	.03 .06 127	.04 .06 129	.03 .07 130	.05 .06 169	.05 .08 186	.05 .07 215
35 N 121 W	.02 .03 525	.03 .04 477	.03 .04 613	.03 .04 572	.03 .03 586	.03 .04 651	.02 .02 631	.02 .03 564	.02 .02 536	.02 .03 658	.02 .03 559	.03 .04 447
35 N 122 W	.03 .05 296	.03 .05 310	.04 .05 376	.03 .05 388	.03 .04 432	.02 .04 480	.03 .04 441	.02 .03 445	.02 .03 418	.03 .04 422	.02 .04 423	.02 .05 274
35 N 123 W	.04 .07 243	.04 .08 218	.04 .07 224	.03 .06 284	.03 .06 276	.04 .06 296	.03 .04 293	.02 .06 325	.02 .04 306	.02 .04 262	.03 .06 283	.04 .08 211
35 N 124 W	.04 .08 222	.05 .09 202	.04 .08 186	.05 .08 189	.03 .06 243	.04 .06 229	.03 .06 225	.03 .05 243	.02 .04 204	.02 .05 279	.03 .06 237	.05 .09 202
35 N 125 W	.07 .12 207	.04 .07 178	.05 .08 171	.05 .09 165	.05 .09 161	.04 .07 200	.03 .06 177	.03 .06 174	.04 .07 174	.03 .07 187	.03 .06 207	.06 .10 169
35 N 126 W	.06 .12 189	.07 .10 147	.05 .12 157	.04 .10 183	.06 .08 141	.04 .08 134	.04 .08 138	.04 .06 147	.04 .07 139	.04 .08 174	.04 .08 179	.06 .08 184
35 N 127 W	.05 .09 193	.05 .08 181	.06 .08 198	.05 .08 171	.04 .09 153	.05 .07 154	.04 .08 129	.03 .06 150	.03 .07 111	.05 .08 206	.05 .09 191	.05 .09 201
35 N 128 W	.04 .06 366	.05 .07 317	.04 .06 373	.05 .05 259	.03 .05 270	.02 .06 243	.02 .05 313	.02 .04 316	.03 .06 273	.02 .05 356	.03 .05 370	.05 .06 368
35 N 129 W	.04 .06 400	.05 .06 394	.03 .05 479	.04 .05 379	.02 .04 352	.02 .04 337	.02 .04 312	.02 .03 326	.02 .05 324	.03 .05 404	.03 .05 373	.04 .05 411
35 N 130 W	.04 .05 568	.04 .05 523	.03 .05 577	.04 .04 487	.02 .04 492	.02 .03 442	.02 .04 464	.01 .03 446	.02 .04 476	.02 .04 592	.03 .04 554	.03 .05 562

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
36 N 122 W	.02 .04 552	.03 .05 465	.03 .04 592	.02 .04 621	.03 .04 631	.02 .03 759	.02 .03 767	.02 .03 561	.02 .03 604	.02 .04 553	.02 .03 561	.03 .04 411
36 N 123 W	.03 .06 286	.04 .06 342	.03 .06 298	.03 .07 364	.02 .04 468	.02 .04 591	.02 .04 577	.02 .03 525	.02 .03 478	.02 .05 418	.03 .05 380	.04 .09 247
36 N 124 W	.05 .08 240	.03 .08 228	.04 .06 215	.03 .07 279	.03 .05 360	.03 .05 351	.03 .05 339	.02 .04 360	.03 .05 286	.02 .06 269	.03 .06 257	.04 .06 246
36 N 125 W	.05 .08 296	.04 .09 206	.04 .07 225	.04 .08 271	.04 .06 281	.03 .06 298	.03 .06 297	.03 .05 291	.02 .07 258	.03 .07 250	.03 .06 270	.04 .07 255
36 N 126 W	.04 .08 446	.03 .06 414	.03 .06 449	.03 .06 368	.03 .05 371	.03 .06 357	.02 .05 358	.02 .04 382	.02 .06 352	.03 .06 398	.02 .05 530	.04 .07 397
36 N 127 W	.02 .04 899	.03 .05 748	.03 .04 694	.02 .04 624	.02 .04 651	.02 .04 655	.02 .04 584	.01 .03 714	.02 .04 646	.02 .04 699	.02 .04 660	.02 .05 734
36 N 128 W	.02 .04 1060	.03 .04 975	.02 .03 963	.02 .03 855	.01 .03 769	.01 .03 868	.01 .03 861	.01 .02 952	.01 .04 929	.02 .03 913	.02 .03 1168	.02 .03 997
36 N 129 W	.04 .05 519	.04 .05 511	.03 .04 682	.03 .04 616	.02 .04 566	.02 .04 581	.01 .03 552	.01 .03 585	.01 .03 637	.03 .04 612	.03 .04 598	.04 .06 620
36 N 130 W	.06 .08 303	.06 .06 315	.04 .06 382	.05 .06 331	.03 .06 274	.02 .05 298	.02 .05 249	.02 .04 259	.04 .05 299	.03 .04 373	.04 .05 404	.06 .07 322
36 N 131 W	.08 .09 235	.08 .08 266	.06 .08 272	.05 .07 238	.04 .06 212	.04 .05 209	.03 .05 138	.03 .05 185	.04 .06 191	.04 .06 250	.06 .08 251	.07 .08 234
37 N 122 W	.03 .05 412	.03 .05 337	.03 .04 343	.03 .04 378	.03 .04 432	.03 .04 391	.01 .02 581	.02 .03 354	.02 .03 400	.02 .03 433	.02 .04 376	.03 .05 325
37 N 123 W	.03 .05 688	.03 .06 591	.04 .05 688	.03 .05 672	.03 .04 738	.02 .03 998	.02 .02 881	.01 .03 836	.01 .02 882	.02 .04 797	.03 .04 687	.04 .06 637
37 N 124 W	.04 .07 578	.04 .06 572	.03 .05 605	.03 .05 514	.04 .06 504	.03 .05 570	.03 .04 523	.02 .04 537	.02 .04 533	.03 .05 602	.02 .04 645	.03 .05 534
37 N 125 W	.02 .05 731	.03 .05 586	.02 .04 789	.02 .05 719	.02 .04 748	.02 .04 696	.02 .03 706	.02 .03 681	.02 .04 664	.02 .04 755	.02 .04 883	.02 .05 688
37 N 126 W	.03 .05 633	.02 .05 545	.02 .05 696	.02 .05 703	.02 .05 685	.02 .04 720	.02 .04 684	.01 .03 603	.02 .04 602	.01 .04 651	.02 .04 722	.02 .05 617
37 N 127 W	.04 .06 435	.04 .08 391	.03 .06 424	.03 .05 473	.02 .05 532	.02 .06 447	.02 .05 438	.02 .05 406	.02 .05 453	.02 .05 528	.04 .05 489	.03 .07 430
37 N 128 W	.06 .08 313	.06 .08 299	.04 .07 352	.03 .06 343	.02 .05 369	.02 .05 361	.03 .06 286	.02 .06 274	.02 .06 405	.02 .05 410	.04 .06 357	.06 .07 337
37 N 129 W	.06 .08 263	.06 .08 236	.06 .09 279	.04 .06 322	.04 .06 306	.03 .06 331	.02 .06 253	.02 .05 283	.02 .05 333	.03 .05 387	.04 .06 351	.06 .09 271
37 N 130 W	.06 .09 233	.06 .08 230	.05 .08 243	.04 .07 312	.04 .05 281	.02 .05 306	.02 .05 271	.03 .05 261	.03 .05 345	.03 .05 338	.05 .06 298	.06 .10 257
37 N 131 W	.07 .09 223	.07 .10 201	.08 .10 209	.05 .05 266	.04 .05 229	.04 .06 239	.02 .05 234	.02 .04 242	.03 .05 262	.04 .05 291	.05 .07 266	.07 .08 254
38 N 123 W	.02 .03 956	.02 .03 919	.03 .03 937	.03 .03 1139	.02 .03 1121	.03 .03 1034	.01 .02 1132	.02 .02 931	.01 .02 1025	.01 .03 985	.02 .03 827	.03 .03 791
38 N 124 W	.04 .09 319	.04 .08 332	.04 .06 351	.03 .05 464	.04 .06 459	.03 .05 568	.03 .05 560	.02 .04 563	.02 .04 533	.03 .04 423	.03 .05 530	.04 .07 453
38 N 125 W	.05 .09 208	.05 .10 222	.05 .12 216	.04 .08 296	.04 .09 274	.04 .07 315	.03 .06 338	.03 .05 370	.03 .07 327	.03 .07 287	.03 .06 289	.05 .09 222
38 N 126 W	.08 .14 162	.04 .11 229	.05 .09 191	.04 .10 216	.03 .08 259	.03 .08 248	.04 .06 292	.03 .05 340	.03 .06 300	.03 .09 272	.06 .08 239	.07 .12 211
38 N 127 W	.07 .17 175	.07 .11 176	.05 .08 233	.04 .08 243	.02 .07 318	.03 .06 338	.03 .06 384	.03 .06 349	.03 .06 318	.03 .08 285	.04 .06 266	.08 .11 214
38 N 128 W	.06 .13 216	.09 .12 193	.04 .07 261	.04 .07 277	.03 .05 383	.02 .06 381	.02 .05 449	.02 .04 435	.02 .05 416	.04 .07 300	.05 .07 282	.07 .09 239
38 N 129 W	.08 .13 177	.06 .11 206	.06 .09 214	.05 .05 247	.03 .05 307	.02 .09 330	.02 .05 355	.02 .05 337	.03 .05 320	.03 .07 249	.05 .06 253	.08 .09 217
38 N 130 W	.09 .15 140	.12 .11 172	.07 .10 170	.06 .08 180	.03 .06 247	.03 .05 258	.03 .05 273	.02 .04 281	.03 .05 272	.05 .08 192	.08 .09 206	.10 .10 196
38 N 131 W	.09 .13 160	.08 .12 146	.07 .12 151	.07 .09 151	.03 .05 248	.04 .08 201	.03 .05 232	.02 .04 291	.04 .06 221	.06 .08 198	.07 .08 174	.08 .12 190
38 N 132 W	.11 .17 126	.13 .12 139	.08 .08 166	.07 .09 145	.05 .07 189	.04 .06 181	.03 .05 208	.06 .05 225	.04 .04 238	.08 .08 193	.07 .08 178	.11 .12 157

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
39 N 124 W	.04 .08 337	.04 .07 393	.03 .06 392	.04 .06 437	.05 .08 423	.04 .06 496	.03 .07 465	.03 .05 415	.03 .05 420	.02 .05 406	.03 .05 422	.09 .12 344
39 N 125 W	.10 .12 181	.06 .10 171	.08 .15 162	.05 .10 202	.05 .10 229	.05 .10 273	.04 .08 311	.04 .08 267	.04 .09 242	.04 .08 218	.05 .12 157	.05 .12 158
39 N 126 W	.07 .17 172	.09 .11 160	.07 .11 165	.04 .09 231	.04 .09 232	.03 .07 301	.03 .06 331	.03 .07 318	.03 .07 269	.07 .17 220	.06 .09 206	.08 .13 155
39 N 127 W	.09 .17 134	.06 .09 173	.07 .13 167	.05 .10 213	.05 .10 173	.05 .10 182	.04 .08 222	.03 .07 244	.04 .09 196	.05 .12 197	.08 .10 174	.08 .13 141
39 N 128 W	.07 .14 138	.10 .11 135	.07 .13 169	.06 .11 164	.04 .10 161	.04 .09 167	.03 .07 233	.03 .07 219	.03 .07 227	.05 .10 171	.07 .20 163	.08 .11 136
39 N 129 W	.07 .11 133	.10 .10 162	.07 .10 202	.05 .09 229	.04 .06 249	.03 .06 254	.02 .06 288	.03 .06 248	.03 .07 238	.06 .09 178	.06 .09 184	.07 .09 172
39 N 130 W	.07 .08 304	.07 .07 337	.05 .07 248	.03 .07 349	.03 .04 451	.02 .04 339	.02 .05 356	.02 .05 324	.03 .06 251	.06 .10 239	.07 .09 187	.05 .07 335
39 N 131 W	.13 .13 138	.11 .13 149	.06 .08 192	.04 .05 216	.04 .04 347	.03 .05 264	.02 .04 400	.02 .03 357	.04 .07 284	.06 .08 187	.09 .09 198	.08 .10 174
39 N 132 W	.10 .12 135	.13 .15 101	.10 .12 157	.06 .08 163	.05 .07 185	.04 .05 251	.02 .04 269	.03 .06 219	.04 .06 235	.04 .07 159	.09 .10 172	.13 .14 148
39 N 133 W	.12 .18 132	.10 .21 112	.08 .11 145	.06 .11 149	.05 .08 162	.03 .05 206	.03 .04 240	.03 .05 186	.04 .04 246	.05 .06 316	.09 .08 220	.08 .11 150
40 N 124 W	.03 .09 727	.03 .06 710	.03 .07 747	.02 .05 736	.02 .05 853	.02 .04 605	.03 .05 658	.05 .06 517	.02 .04 478	.02 .06 490	.02 .07 525	.04 .08 454
40 N 125 W	.07 .15 178	.07 .14 168	.05 .11 184	.04 .11 210	.05 .12 167	.04 .09 223	.05 .09 212	.04 .09 233	.04 .11 193	.03 .12 191	.05 .11 213	.07 .15 151
40 N 126 W	.09 .18 111	.06 .28 75	.11 .19 80	.05 .13 102	.10 .14 124	.06 .17 105	.05 .12 127	.04 .11 127	.05 .13 95	.06 .13 114	.07 .17 128	.09 .23 101
40 N 127 W	.09 .14 127	.09 .13 122	.13 .16 115	.05 .11 165	.04 .09 167	.03 .08 196	.04 .09 204	.03 .06 270	.04 .09 162	.05 .12 169	.07 .16 122	.08 .13 123
40 N 128 W	.06 .12 287	.09 .14 162	.10 .11 153	.05 .08 212	.03 .08 201	.03 .21 248	.02 .07 301	.03 .06 247	.04 .08 205	.05 .09 190	.08 .12 136	.08 .09 225
40 N 129 W	.07 .10 167	.06 .11 189	.05 .07 276	.05 .07 305	.04 .05 279	.03 .06 230	.03 .05 268	.04 .06 249	.05 .08 243	.04 .08 253	.08 .09 218	.07 .11 158
40 N 130 W	.07 .08 209	.06 .07 295	.05 .05 568	.04 .05 479	.03 .04 519	.02 .04 519	.02 .05 499	.02 .06 393	.04 .06 359	.04 .05 472	.05 .06 396	.05 .08 197
40 N 131 W	.10 .15 108	.11 .12 156	.08 .10 145	.07 .08 168	.05 .15 191	.03 .06 185	.04 .05 216	.02 .04 245	.05 .06 170	.07 .07 147	.08 .10 153	.11 .12 129
40 N 132 W	.11 .10 165	.10 .09 162	.08 .10 182	.05 .07 183	.05 .06 232	.02 .04 261	.02 .04 304	.02 .03 271	.04 .05 233	.13 .08 213	.08 .09 177	.10 .13 173
40 N 133 W	.09 .11 172	.17 .09 166	.08 .08 226	.04 .06 291	.04 .05 268	.02 .03 384	.02 .03 375	.02 .04 341	.03 .04 429	.11 .06 362	.08 .07 235	.09 .11 203
41 N 124 W	.08 .17 102	.04 .10 112	.05 .12 101	.05 .21 114	.05 .12 125	.04 .11 120	.08 .14 114	.02 .06 180	.02 .06 208	.03 .06 212	.04 .08 209	.07 .07 178
41 N 125 W	.06 .16 204	.05 .14 227	.03 .09 256	.03 .11 226	.03 .10 243	.03 .09 258	.04 .09 271	.03 .08 236	.03 .10 236	.04 .11 271	.03 .11 246	.11 .17 192
41 N 126 W	.17 .16 77	.09 .19 77	.12 .29 82	.08 .15 93	.04 .16 102	.05 .14 87	.12 .29 84	.06 .14 87	.04 .18 91	.08 .27 118	.05 .15 101	.10 .19 98
41 N 127 W	.12 .22 88	.16 .17 84	.16 .26 79	.12 .17 117	.04 .10 105	.08 .18 66	.07 .14 64	.06 .12 85	.09 .20 60	.07 .15 82	.11 .19 94	.14 .21 84
41 N 128 W	.29 .25 77	.13 .14 60	.20 .36 66	.06 .09 101	.08 .13 69	.06 .13 76	.04 .13 83	.04 .14 77	.05 .12 65	.08 .12 89	.16 .24 83	.14 .14 86
41 N 129 W	.13 .18 103	.12 .18 97	.50 .43 108	.06 .08 120	.06 .09 119	.03 .06 154	.03 .07 137	.05 .07 122	.04 .09 118	.09 .11 111	.10 .12 107	.20 .14 113
41 N 130 W	.18 .14 113	.11 .16 156	.11 .09 164	.04 .05 216	.04 .06 218	.03 .05 274	.02 .05 253	.02 .05 295	.05 .06 199	.08 .08 206	.08 .10 154	.10 .15 122
41 N 131 W	.09 .12 175	.12 .16 202	.09 .10 221	.05 .06 289	.04 .06 268	.02 .04 270	.05 .11 344	.03 .03 341	.04 .05 247	.05 .08 227	.08 .12 195	.09 .11 161
41 N 132 W	.10 .12 116	.14 .18 113	.10 .12 115	.08 .09 155	.08 .09 161	.05 .05 161	.03 .05 171	.04 .07 152	.06 .07 148	.09 .08 162	.12 .11 139	.12 .17 131
41 N 133 W	.12 .16 117	.12 .18 99	.13 .16 115	.07 .09 133	.08 .08 118	.04 .05 157	.04 .26 152	.03 .05 168	.05 .07 141	.08 .11 137	.15 .12 113	.10 .13 123

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
42 N 124 W	.08 .15 103	.06 .14 107	.06 .12 74	.05 .15 92	.05 .13 96	.05 .09 112	.05 .13 128	.05 .13 90	.03 .10 112	.02 .09 112	.07 .17 88	.06 .12 76
42 N 125 W	.06 .12 221	.06 .11 241	.04 .08 273	.03 .11 258	.04 .14 214	.03 .10 303	.03 .09 296	.03 .09 238	.03 .10 243	.03 .08 268	.03 .10 272	.06 .15 196
42 N 126 W	.17 .28 73	.15 .25 60	.15 .21 77	.08 .14 80	.08 .15 75	.06 .13 61	.07 .17 63	.04 .12 76	.08 .21 50	.10 .23 73	.09 .15 77	.17 .23 58
42 N 127 W	.18 .21 86	.09 .17 82	.18 .23 95	.10 .21 89	.05 .09 83	.07 .11 73	.08 .12 72	.06 .11 64	.08 .18 69	.11 .15 94	.12 .15 114	.14 .16 102
42 N 128 W	.24 .20 94	.10 .18 64	.23 .24 87	.10 .13 68	.07 .14 70	.10 .25 67	.06 .15 67	.07 .18 61	.09 .11 53	.08 .13 82	.14 .25 86	.16 .20 110
42 N 129 W	.12 .16 212	.10 .13 166	.06 .09 260	.06 .07 244	.06 .07 241	.04 .07 157	.04 .06 143	.02 .05 264	.11 .13 48	.14 .19 61	.11 .13 152	.10 .11 257
42 N 130 W	.10 .14 146	.14 .17 142	.12 .12 124	.07 .09 93	.05 .09 100	.04 .07 139	.04 .09 128	.32 .39 100	.21 .09 52	.12 .12 76	.12 .10 137	.14 .19 114
42 N 131 W	.07 .09 187	.14 .13 158	.07 .10 199	.07 .06 216	.05 .07 160	.04 .05 183	.03 .04 280	.02 .04 288	.05 .07 206	.10 .09 166	.10 .13 158	.13 .12 138
42 N 132 W	.13 .17 121	.11 .18 120	.15 .13 123	.08 .09 186	.05 .05 194	.04 .05 228	.03 .05 249	.04 .05 234	.04 .06 190	.08 .09 159	.12 .19 116	.12 .21 126
42 N 133 W	.15 .15 144	.16 .18 110	.13 .10 167	.07 .09 181	.06 .07 256	.05 .08 257	.03 .04 233	.03 .03 259	.04 .05 219	.08 .07 200	.15 .17 119	.12 .15 139
43 N 124 W	.11 .14 95	.09 .11 100	.06 .12 80	.03 .12 84	.06 .10 87	.03 .07 104	.03 .10 92	.03 .09 76	.02 .06 123	.02 .08 103	.08 .21 72	.07 .13 104
43 N 125 W	.06 .13 254	.04 .13 272	.06 .10 255	.03 .09 241	.03 .09 241	.02 .07 280	.02 .06 304	.02 .06 213	.02 .09 281	.10 .07 456	.04 .09 423	.06 .15 224
43 N 126 W	.13 .19 71	.13 .22 58	.15 .14 61	.13 .12 59	.06 .14 59	.06 .17 41	.07 .16 42	.03 .17 52	.07 .21 47	.07 .12 87	.13 .15 77	.12 .23 68
43 N 127 W	.24 .33 71	.13 .22 64	.12 .20 84	.10 .18 64	.06 .09 64	.06 .13 48	.04 .10 58	.11 .17 54	.07 .14 53	.09 .13 105	.11 .15 110	.20 .25 83
43 N 128 W	.18 .21 85	.23 .31 78	.30 .22 75	.11 .14 68	.06 .11 69	.04 .08 64	.09 .11 64	.05 .08 54	.07 .12 71	.09 .17 88	.14 .15 104	.16 .22 105
43 N 129 W	.14 .17 136	.16 .21 98	.14 .15 123	.09 .13 93	.12 .13 97	.09 .23 87	.05 .08 76	.05 .10 86	.07 .08 77	.12 .17 82	.15 .18 105	.13 .23 107
43 N 130 W	.08 .10 330	.08 .12 156	.08 .10 306	.05 .08 317	.03 .05 346	.02 .05 369	.02 .05 320	.02 .04 330	.03 .05 288	.09 .10 173	.12 .12 118	.07 .10 332
43 N 131 W	.12 .15 119	.10 .14 149	.11 .11 139	.11 .14 117	.05 .10 133	.04 .05 150	.04 .06 150	.02 .05 169	.06 .09 126	.10 .09 130	.11 .12 116	.19 .22 103
43 N 132 W	.15 .19 99	.12 .26 101	.13 .15 114	.11 .16 96	.10 .09 85	.07 .08 83	.05 .07 94	.05 .08 84	.08 .10 75	.14 .12 81	.19 .20 78	.17 .22 79
43 N 133 W	.14 .13 127	.12 .17 112	.09 .10 117	.09 .09 147	.08 .09 122	.04 .06 128	.04 .05 115	.06 .05 129	.07 .07 100	.09 .12 149	.13 .12 143	.20 .47 121
44 N 124 W	.09 .17 126	.08 .10 133	.09 .16 118	.04 .08 136	.03 .06 162	.01 .07 133	.02 .05 161	.01 .05 95	.03 .05 138	.03 .08 156	.04 .09 174	.11 .16 94
44 N 125 W	.07 .14 229	.05 .10 252	.05 .09 305	.03 .08 237	.06 .07 259	.02 .06 271	.01 .05 341	.01 .05 286	.01 .04 540	.02 .07 492	.03 .06 437	.08 .18 221
44 N 126 W	.17 .23 84	.14 .25 45	.09 .16 68	.18 .65 52	.06 .10 73	.05 .12 63	.05 .17 61	.02 .09 76	.10 .24 39	.16 .19 80	.09 .13 76	.17 .32 65
44 N 127 W	.20 .28 75	.20 .23 62	.13 .21 77	.14 .17 55	.08 .12 77	.08 .11 55	.05 .15 42	.04 .09 64	.10 .12 61	.13 .16 77	.09 .14 103	.17 .30 81
44 N 128 W	.19 .22 99	.16 .23 124	.15 .17 103	.10 .10 90	.06 .11 109	.27 .47 83	.05 .11 79	.05 .08 74	.05 .10 124	.05 .07 288	.07 .12 270	.25 .22 103
44 N 129 W	.15 .18 99	.14 .17 94	.16 .17 115	.10 .13 125	.07 .06 102	.05 .11 107	.04 .07 104	.04 .08 94	.05 .08 119	.07 .11 168	.16 .12 145	.18 .22 139
44 N 130 W	.10 .14 134	.11 .15 116	.16 .16 126	.10 .16 102	.09 .14 110	.07 .20 110	.04 .09 110	.06 .09 91	.05 .09 113	.09 .14 125	.13 .20 117	.16 .19 117
44 N 131 W	.10 .12 231	.09 .10 194	.07 .07 318	.05 .06 256	.04 .06 288	.02 .04 417	.02 .04 384	.05 .03 385	.03 .05 381	.04 .07 372	.06 .08 273	.13 .14 238
44 N 132 W	.12 .14 170	.11 .17 150	.11 .11 167	.07 .07 181	.06 .08 177	.05 .06 169	.03 .05 175	.03 .05 149	.05 .08 143	.08 .10 173	.13 .12 151	.11 .17 177
44 N 133 W	.14 .16 137	.15 .16 133	.13 .12 118	.12 .11 101	.07 .07 105	.08 .07 110	.06 .06 108	.04 .07 109	.07 .10 100	.11 .10 137	.13 .14 116	.11 .15 135

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
45 N 124 W	.11 .12 175	.06 .08 188	.06 .09 164	.04 .09 150	.04 .06 219	.01 .04 230	.01 .05 204	.01 .04 182	.02 .07 161	.04 .07 211	.10 .12 175	.11 .14 141
45 N 125 W	.06 .10 277	.04 .08 338	.06 .10 329	.04 .06 277	.03 .05 344	.01 .05 349	.01 .04 368	.01 .04 238	.01 .03 422	.03 .06 458	.05 .10 355	.10 .14 233
45 N 126 W	.13 .24 109	.08 .12 116	.14 .18 83	.07 .15 87	.05 .08 103	.03 .08 129	.05 .13 87	.05 .08 96	.09 .12 99	.14 .10 115	.11 .16 113	.18 .27 101
45 N 127 W	.19 .26 98	.14 .17 101	.12 .17 115	.09 .18 82	.06 .11 104	.05 .08 75	.06 .11 81	.04 .07 81	.06 .12 72	.12 .12 110	.11 .15 132	.20 .29 86
45 N 128 W	.11 .20 102	.13 .14 99	.10 .15 113	.09 .21 105	.04 .04 297	.05 .07 100	.05 .08 79	.03 .07 147	.07 .11 71	.17 .15 113	.14 .13 121	.29 .27 85
45 N 129 W	.14 .19 119	.13 .13 97	.11 .16 144	.08 .10 109	.06 .09 100	.05 .07 115	.05 .08 97	.04 .07 95	.08 .08 123	.19 .14 117	.12 .18 131	.11 .16 109
45 N 130 W	.06 .07 507	.06 .08 500	.05 .05 539	.04 .05 554	.03 .05 386	.03 .03 420	.01 .04 559	.03 .03 307	.03 .03 471	.06 .06 379	.07 .09 482	.08 .10 425
45 N 131 W	.08 .10 257	.09 .10 273	.07 .07 284	.05 .07 223	.04 .06 260	.03 .04 251	.09 .04 274	.03 .05 222	.05 .07 209	.07 .08 216	.10 .12 199	.11 .12 255
45 N 132 W	.12 .17 166	.12 .12 143	.11 .10 163	.08 .08 192	.07 .07 170	.04 .06 167	.05 .06 129	.05 .06 141	.06 .08 145	.10 .11 160	.09 .13 132	.18 .16 127
45 N 133 W	.23 .29 61	.29 .25 53	.23 .22 59	.15 .16 59	.16 .12 55	.07 .09 68	.08 .08 56	.09 .12 45	.07 .09 56	.13 .15 93	.16 .18 79	.25 .34 75
46 N 124 W	.04 .04 907	.04 .06 660	.03 .07 692	.03 .05 694	.03 .04 709	.02 .03 712	.01 .02 771	.01 .02 696	.02 .03 724	.03 .05 818	.04 .06 719	.06 .08 675
46 N 125 W	.09 .10 220	.07 .10 222	.08 .08 269	.05 .09 204	.03 .05 246	.02 .04 291	.02 .04 314	.01 .04 255	.04 .06 269	.07 .09 285	.07 .12 258	.13 .14 154
46 N 126 W	.13 .19 100	.13 .19 93	.18 .17 84	.09 .13 74	.06 .10 82	.07 .13 78	.04 .08 95	.04 .08 87	.19 .16 88	.11 .27 89	.24 .27 115	.27 .21 76
46 N 127 W	.14 .16 126	.11 .13 120	.11 .14 140	.08 .11 108	.05 .05 100	.07 .10 96	.05 .09 102	.03 .06 98	.06 .11 95	.15 .15 105	.12 .14 181	.18 .15 114
46 N 128 W	.12 .17 139	.16 .15 148	.10 .11 164	.08 .10 118	.07 .08 109	.05 .08 106	.04 .08 113	.05 .06 110	.06 .07 118	.11 .12 139	.14 .17 145	.12 .13 145
46 N 129 W	.16 .17 145	.13 .16 136	.12 .11 154	.15 .11 129	.05 .09 116	.05 .06 115	.05 .06 107	.04 .05 120	.05 .09 113	.10 .14 133	.10 .12 136	.13 .18 145
46 N 130 W	.11 .14 131	.14 .16 130	.11 .12 152	.15 .12 123	.06 .06 120	.06 .08 140	.05 .07 114	.05 .08 98	.09 .12 102	.14 .11 123	.12 .12 137	.13 .16 130
46 N 131 W	.14 .15 141	.12 .16 107	.11 .15 112	.07 .10 158	.05 .08 157	.04 .05 142	.04 .07 123	.05 .05 144	.08 .08 141	.13 .13 125	.15 .17 154	.12 .12 148
46 N 132 W	.10 .10 240	.09 .09 182	.09 .08 254	.08 .08 296	.03 .05 229	.06 .06 145	.14 .12 138	.06 .08 121	.07 .08 151	.09 .12 121	.13 .14 114	.16 .17 134
46 N 133 W	.15 .14 106	.17 .20 92	.15 .15 83	.12 .12 95	.14 .14 92	.07 .08 77	.06 .09 74	.05 .06 86	.10 .13 90	.13 .12 105	.17 .18 91	.24 .23 108
47 N 124 W	.18 .15 80	.10 .11 96	.07 .10 81	.08 .10 83	.04 .09 84	.02 .03 117	.02 .03 119	.02 .04 80	.03 .04 101	.10 .06 102	.07 .09 173	.18 .19 74
47 N 125 W	.10 .12 228	.08 .10 198	.06 .08 252	.07 .09 195	.04 .05 197	.02 .03 356	.01 .02 450	.01 .02 436	.03 .03 274	.04 .17 357	.07 .09 304	.11 .15 155
47 N 126 W	.14 .16 196	.12 .13 158	.10 .11 177	.09 .10 185	.05 .08 174	.06 .08 152	.03 .06 143	.03 .06 174	.09 .10 157	.09 .11 192	.10 .11 223	.12 .14 138
47 N 127 W	.15 .13 171	.10 .12 177	.11 .09 215	.08 .12 171	.05 .08 177	.08 .11 175	.03 .06 149	.05 .06 151	.08 .10 181	.07 .10 170	.11 .13 186	.14 .13 159
47 N 128 W	.15 .12 151	.16 .19 127	.09 .12 156	.10 .13 130	.06 .06 128	.09 .12 119	.08 .06 108	.04 .08 116	.06 .10 183	.08 .09 293	.10 .19 154	.15 .17 125
47 N 129 W	.19 .18 88	.21 .20 100	.13 .16 83	.09 .13 94	.06 .06 99	.06 .08 95	.04 .07 94	.05 .08 86	.08 .09 107	.09 .10 198	.11 .16 115	.16 .18 98
47 N 130 W	.10 .12 262	.10 .12 283	.10 .09 299	.05 .06 276	.05 .05 213	.03 .06 247	.02 .03 270	.02 .05 242	.07 .06 257	.13 .14 148	.19 .21 78	.09 .08 282
47 N 131 W	.08 .13 237	.12 .16 120	.08 .09 180	.06 .08 200	.04 .07 198	.03 .04 267	.03 .04 237	.03 .05 316	.04 .06 326	.11 .11 202	.10 .14 185	.10 .12 262
47 N 132 W	.11 .16 159	.08 .11 206	.09 .10 171	.13 .09 157	.04 .06 265	.03 .03 374	.03 .04 292	.04 .05 259	.04 .06 232	.08 .10 257	.08 .10 248	.11 .17 196
47 N 133 W	.16 .17 77	.18 .19 84	.19 .15 79	.11 .17 88	.10 .14 76	.08 .11 76	.07 .08 61	.06 .10 85	.08 .15 96	.11 .12 114	.20 .22 90	.18 .17 91

LAT/LON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
48 N 125 W	.06 .05 930	.06 .06 739	.04 .06 848	.03 .04 770	.02 .02 767	.01 .01 763	.01 .01 1213	.01 .02 1138	.02 .03 754	.03 .05 795	.05 .05 823	.07 .08 629
48 N 126 W	.12 .12 304	.11 .09 209	.10 .08 252	.07 .07 198	.06 .09 185	.05 .05 197	.02 .03 324	.02 .02 327	.03 .04 298	.07 .05 400	.09 .09 331	.12 .12 201
48 N 127 W	.12 .12 143	.12 .13 131	.10 .12 130	.09 .14 101	.08 .10 151	.06 .07 140	.06 .07 137	.04 .06 134	.04 .06 206	.09 .11 136	.09 .11 247	.17 .15 137
48 N 128 W	.12 .14 114	.11 .16 131	.09 .09 139	.06 .08 147	.06 .08 148	.05 .06 133	.05 .08 118	.05 .07 115	.08 .14 130	.13 .14 134	.14 .16 142	.15 .16 136
48 N 129 W	.12 .17 111	.14 .12 125	.10 .11 126	.07 .10 110	.06 .08 147	.05 .08 113	.05 .08 135	.04 .08 131	.08 .14 141	.11 .15 117	.13 .16 114	.13 .15 122
48 N 130 W	.14 .15 132	.11 .17 108	.09 .10 136	.13 .11 123	.07 .09 131	.45 .18 138	.06 .09 120	.04 .06 148	.08 .09 179	.10 .15 131	.14 .16 134	.15 .16 141
48 N 131 W	.19 .18 143	.11 .13 126	.11 .12 134	.05 .07 167	.05 .06 207	.04 .05 168	.03 .04 173	.04 .06 161	.07 .09 178	.10 .14 169	.11 .16 162	.10 .15 184
48 N 132 W	.08 .08 322	.07 .07 302	.06 .06 335	.05 .07 321	.03 .04 380	.03 .05 205	.04 .06 192	.04 .05 192	.07 .08 209	.13 .13 161	.11 .12 197	.08 .10 295
48 N 133 W	.12 .13 124	.14 .16 95	.13 .15 116	.08 .12 134	.08 .08 136	.07 .07 133	.04 .05 137	.06 .09 107	.10 .09 147	.13 .12 143	.12 .16 147	.15 .15 153
48 N 134 W	.16 .17 82	.18 .26 107	.15 .14 97	.13 .13 104	.08 .07 118	.06 .08 118	.05 .05 94	.08 .07 91	.10 .13 96	.22 .34 114	.13 .14 132	.28 .25 114
49 N 126 W	.20 .13 98	.09 .09 140	.20 .13 124	.08 .08 141	.06 .05 149	.06 .05 145	.03 .02 406	.02 .02 378	.05 .04 235	.07 .06 207	.09 .12 122	.15 .16 106
49 N 127 W	.12 .12 152	.09 .10 159	.10 .12 170	.08 .10 193	.06 .06 213	.05 .06 209	.04 .03 331	.03 .03 283	.06 .06 268	.08 .08 223	.26 .16 212	.12 .11 169
49 N 128 W	.13 .13 185	.08 .12 175	.10 .09 234	.06 .09 197	.04 .05 453	.04 .05 273	.04 .05 325	.04 .04 322	.06 .07 272	.10 .11 207	.10 .10 267	.14 .13 184
49 N 129 W	.11 .14 184	.10 .09 190	.09 .09 212	.05 .09 245	.05 .06 289	.04 .05 241	.04 .05 272	.03 .05 251	.05 .08 249	.09 .11 233	.09 .11 246	.13 .14 194
49 N 130 W	.13 .12 308	.09 .11 316	.06 .07 314	.06 .07 316	.04 .05 298	.03 .04 298	.03 .05 303	.03 .05 325	.05 .06 345	.07 .09 280	.07 .08 332	.11 .12 304
49 N 131 W	.09 .09 430	.09 .09 388	.06 .08 411	.05 .08 452	.04 .05 330	.02 .03 520	.04 .05 458	.03 .04 330	.05 .06 420	.05 .06 362	.07 .08 368	.07 .11 406
49 N 132 W	.15 .14 182	.10 .11 197	.10 .11 189	.09 .09 191	.05 .05 240	.06 .06 211	.03 .04 235	.04 .05 220	.06 .08 225	.09 .10 227	.11 .10 235	.12 .11 217
49 N 133 W	.11 .14 196	.10 .12 185	.11 .08 225	.07 .09 250	.06 .06 235	.04 .05 244	.03 .04 220	.04 .05 272	.06 .07 251	.11 .10 233	.13 .13 238	.11 .13 190
49 N 134 W	.14 .13 200	.12 .11 179	.10 .09 201	.09 .12 210	.05 .06 249	.05 .05 240	.04 .04 227	.04 .05 252	.07 .07 277	.11 .12 257	.11 .12 262	.11 .12 211
49 N 135 W	.12 .11 183	.11 .11 165	.10 .11 199	.09 .12 217	.08 .07 213	.08 .05 200	.05 .05 184	.05 .06 211	.06 .07 263	.08 .11 243	.09 .11 306	.11 .10 241
50 N 127 W	.38 .26 19	.17 .16 30	.28 .33 20	.55 .32 35	.09 .02 59	.09 .10 27	.05 .05 86	.04 .01 88	.03 .02 160	.10 .07 112	2.75 .51 53	.54 .55 17
50 N 128 W	.18 .17 68	.33 .35 48	.19 .13 68	.11 .17 69	.13 .13 62	.08 .10 95	.09 .08 102	.06 .09 69	.09 .12 77	.10 .10 81	.12 .17 84	.32 .27 61
50 N 129 W	.17 .20 93	.18 .16 78	.13 .17 89	.11 .15 110	.06 .07 136	.08 .09 116	.05 .06 171	.05 .07 148	.07 .11 129	.13 .14 98	.20 .18 106	.22 .24 82
50 N 130 W	.19 .14 124	.13 .13 113	.15 .14 121	.07 .10 140	.05 .06 189	.06 .06 210	.04 .07 216	.05 .07 183	.05 .09 187	.11 .11 152	.13 .20 139	.11 .13 110
50 N 131 W	.13 .17 163	.12 .13 149	.10 .11 160	.07 .10 217	.05 .06 253	.05 .06 202	.04 .05 273	.04 .05 240	.07 .09 248	.10 .10 180	.11 .12 187	.12 .15 154
50 N 132 W	.12 .16 138	.12 .13 129	.12 .10 160	.08 .08 173	.05 .06 223	.04 .06 213	.04 .05 254	.09 .23 234	.06 .08 228	.12 .16 148	.13 .12 170	.14 .23 125
50 N 133 W	.14 .16 125	.14 .14 129	.15 .13 137	.06 .08 189	.06 .06 212	.06 .07 185	.04 .05 214	.04 .05 230	.07 .08 203	.14 .12 166	.16 .15 147	.16 .17 144
50 N 134 W	.12 .11 327	.08 .10 261	.07 .06 331	.06 .08 309	.04 .05 328	.03 .04 409	.03 .04 335	.04 .04 313	.07 .08 203	.11 .11 163	.11 .10 284	.10 .12 289
50 N 135 W	.14 .15 161	.13 .11 162	.11 .11 197	.08 .08 212	.05 .05 255	.04 .04 263	.03 .04 237	.05 .06 237	.05 .06 484	.10 .11 228	.11 .13 222	.15 .15 188
50 N 136 W	.08 .08 485	.09 .08 463	.05 .05 649	.04 .05 681	.04 .04 595	.04 .04 537	.03 .03 384	.04 .04 406	.04 .06 446	.07 .08 499	.08 .07 536	.09 .09 566

APPENDIX III

Monthly Wind Stress Curl Distributions

The monthly mean wind stress curl distributions are displayed in Charts 37 to 48. The plotted values are estimates of the vertical component of the wind stress curl, calculated by applying a finite difference, spherical coordinate curl operator to the fields of monthly mean surface wind stress. The contoured values are plotted in units of dyne cm^{-2}per 100 km. A value of 1.0 dyne cm^{-2} per 100 km is equivalent to 1.0×10^{-7} dyne cm^{-3}. The contour interval is 0.25 dyne cm^{-2}per 100 km. Positive wind stress curl is associated with surface Ekman divergence (upwelling). Negative values are shaded. These correspond to surface Ekman convergence (downwelling).

In the following charts, the month is indicated in the figure legend in the upper right corner of the charts. The coastline configuration is superimposed on the grid as a visual aid and does not represent a conformal mapping.

NCC - TDF-11 - ONE DEGREE SUMMARIZATION

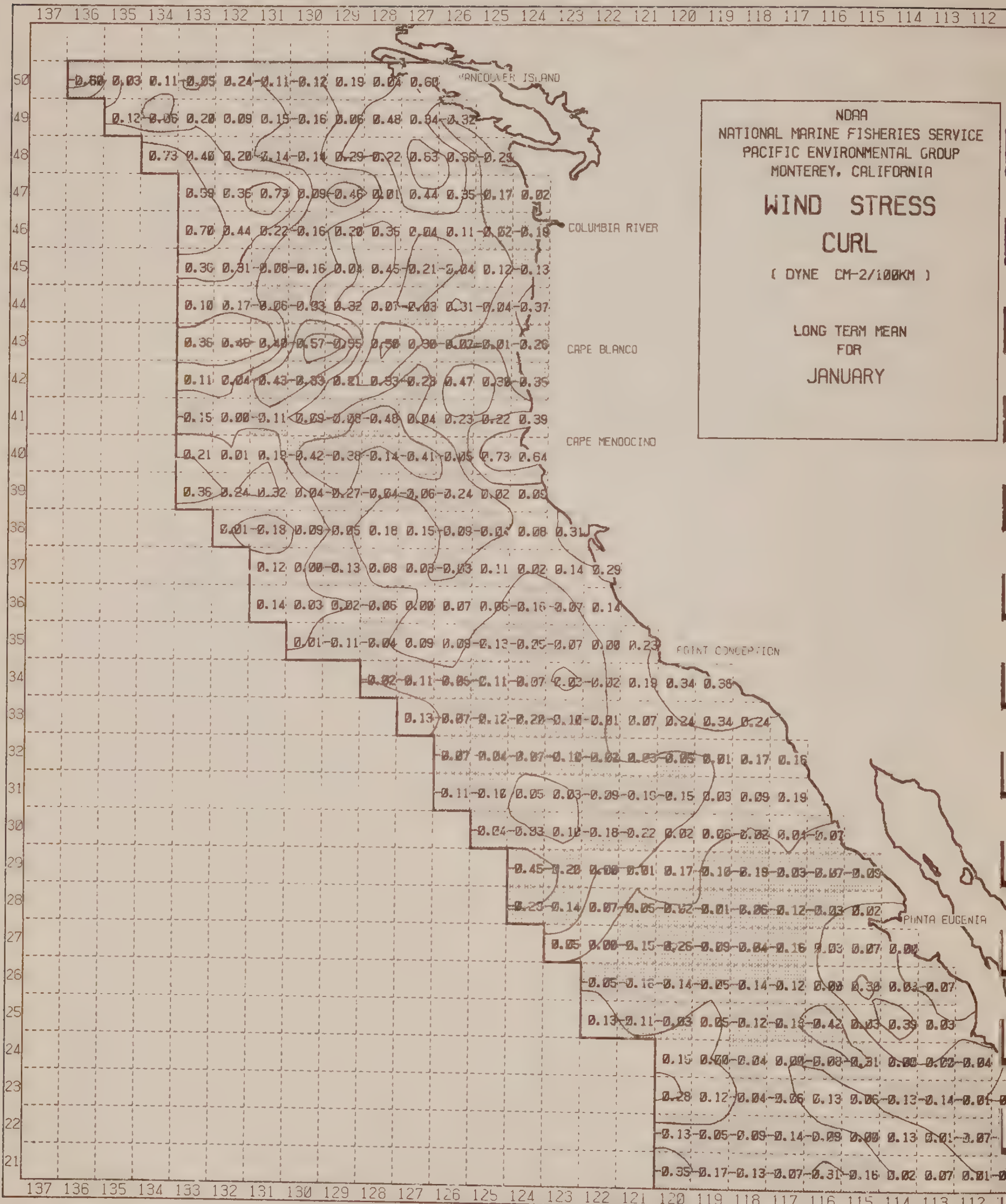

NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
JANUARY
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21

Chart 37.—Wind stress curl for January.

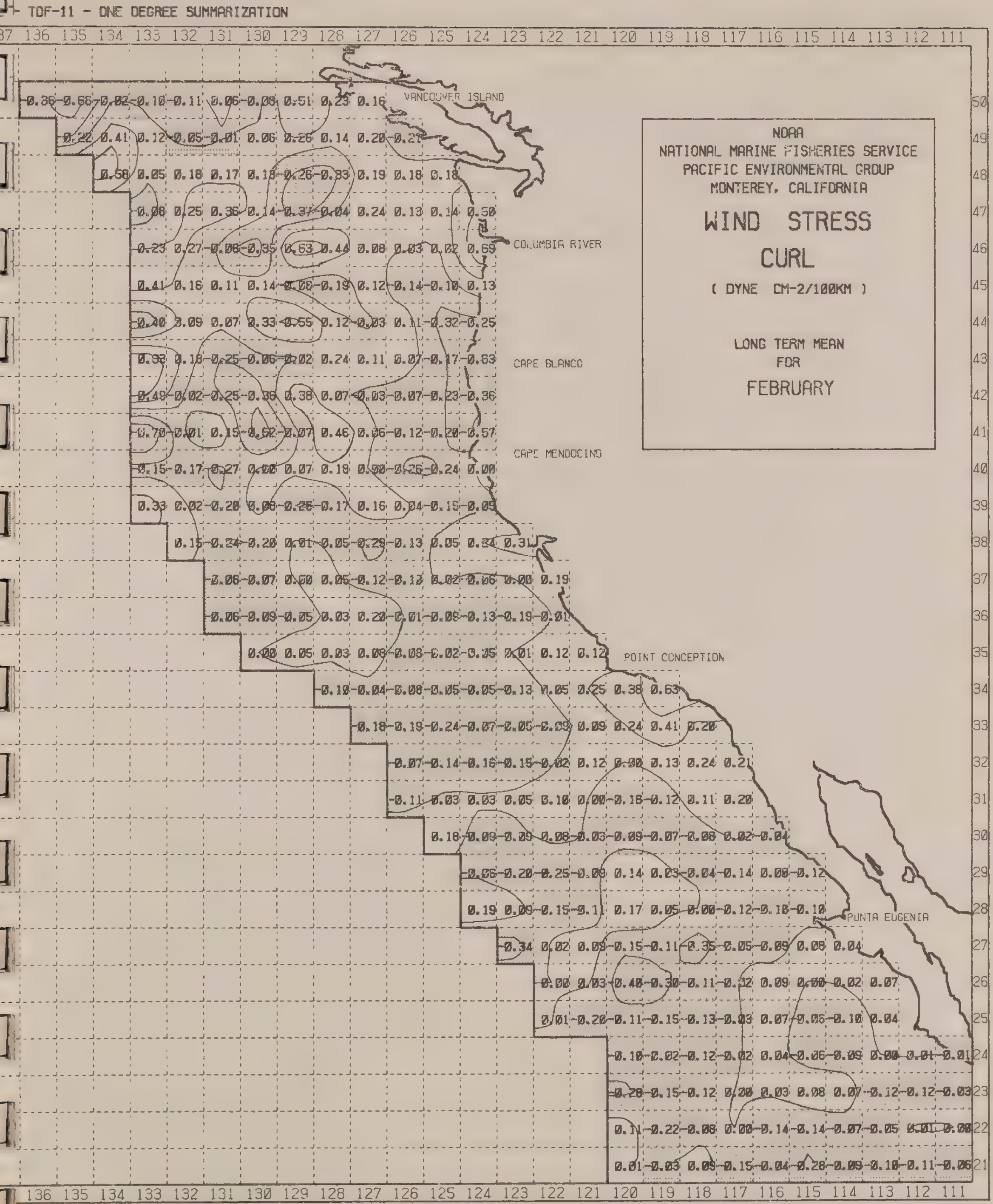

TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
FEBRUARY
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21

Chart 38.—Wind stress curl for February.

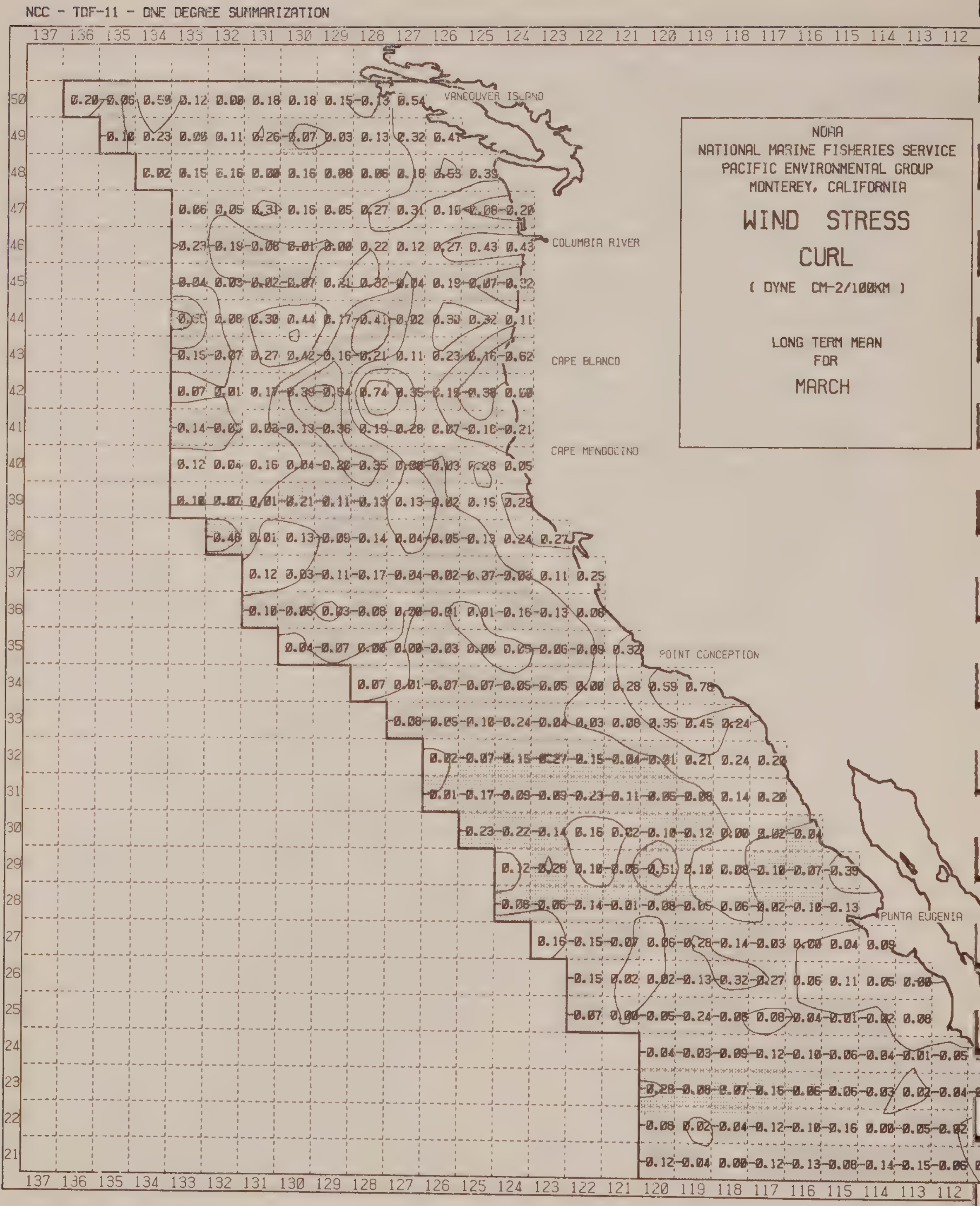

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
MARCH
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.20-0.05 0.59 0.12 0.00 0.18 0.18 0.15-0.13 0.54
-0.10 0.23 0.05 0.11 0.26-0.07 0.03 0.13 0.32 0.41
0.02 0.15 0.16 0.00 0.16 0.08 0.06 0.18 0.53 0.39
0.06 0.05 0.31 0.16 0.05 0.27 0.31 0.10-0.08-0.20
0.23-0.19-0.08 0.01 0.00 0.22 0.12 0.27 0.43 0.43
-0.04 0.03-0.02-0.07 0.21 0.32-0.04 0.19-0.07-0.32
0.60 0.08 0.30 0.44 0.17-0.41-0.02 0.30 0.32 0.11
-0.15-0.07 0.27 0.42-0.16-0.21 0.11 0.23-0.16-0.62
0.07 0.01 0.17-0.39-0.54 0.74 0.35-0.19-0.38 0.00
-0.14-0.05 0.03-0.13-0.36 0.19-0.28 0.07-0.18-0.21
0.12 0.04 0.16 0.04-0.20-0.35 0.00-0.03 0.28 0.05
0.10 0.07 0.01-0.21-0.11-0.13 0.13-0.02 0.15 0.29
-0.46 0.01 0.13-0.09-0.14 0.04-0.05-0.13 0.24 0.27
0.12 0.03-0.11-0.17-0.04-0.02-0.07-0.03 0.11 0.25
-0.10-0.05 0.03-0.08 0.20-0.01 0.01-0.16-0.13 0.08
0.04-0.07 0.00 0.00-0.03 0.00 0.05-0.06-0.09 0.32
0.07 0.01-0.07-0.07-0.05-0.05 0.00 0.28 0.59 0.78
-0.08-0.05-0.10-0.24-0.04 0.03 0.08 0.35 0.45 0.24
0.02-0.07-0.15-0.27-0.15-0.04-0.01 0.21 0.24 0.20
-0.01-0.17-0.09-0.09-0.23-0.11-0.05-0.08 0.14 0.20
-0.23-0.22-0.14 0.16 0.02-0.10-0.12 0.00 0.02-0.04
0.12-0.28 0.10-0.05-0.51 0.10 0.08-0.10-0.07-0.39
-0.08-0.06-0.14-0.01-0.08-0.05 0.06-0.02-0.10-0.13
0.16-0.15-0.07 0.06-0.28-0.14-0.03 0.00 0.04 0.09
-0.15 0.02 0.02-0.13-0.32-0.27 0.06 0.11 0.05 0.00
-0.07 0.00-0.05-0.24-0.08 0.08-0.04-0.01-0.02 0.08
-0.04-0.03-0.09-0.12-0.10-0.06-0.04-0.01-0.05
-0.28-0.08-0.07-0.15-0.06-0.06-0.03 0.02-0.04
-0.08 0.02-0.04-0.12-0.10-0.16 0.00-0.05-0.02
-0.12-0.04 0.00-0.12-0.13-0.08-0.14-0.15-0.06

Chart 39.—Wind stress curl for March.

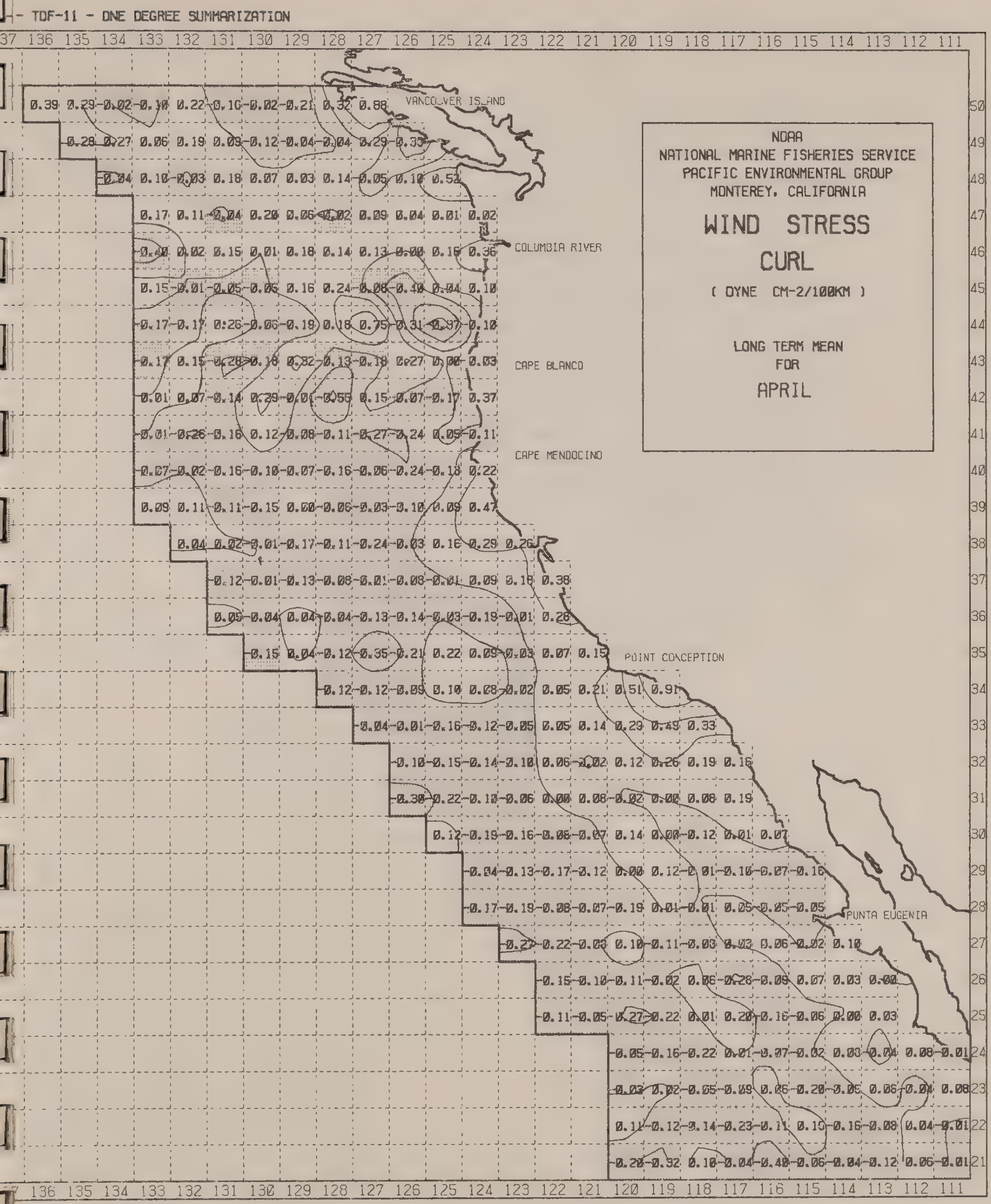

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
APRIL
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.39 0.29 -0.02 -0.10 0.22 -0.10 -0.02 -0.21 0.32 0.88
-0.28 0.27 0.06 0.19 0.09 -0.12 -0.04 -0.04 0.29 -0.33
-0.04 0.10 -0.03 0.18 0.07 0.03 0.14 -0.05 0.10 0.52
0.17 0.11 -0.04 0.20 0.06 -0.02 0.09 0.04 0.01 0.02
-0.40 0.02 0.15 0.01 0.18 0.14 0.13 -0.00 0.16 0.36
0.15 -0.01 -0.05 -0.06 0.16 0.24 -0.06 -0.40 0.04 0.10
-0.17 -0.17 0.26 -0.06 -0.19 0.18 0.75 -0.31 -0.97 -0.10
-0.17 0.15 -0.28 -0.18 0.82 -0.13 -0.18 0.27 0.00 -0.03
-0.01 0.07 -0.14 0.29 -0.01 -0.55 0.15 -0.07 -0.17 0.37
-0.01 -0.26 -0.16 0.12 -0.08 -0.11 -0.27 -0.24 0.05 -0.11
-0.07 -0.02 -0.16 -0.10 -0.07 -0.16 -0.06 -0.24 -0.18 0.22
0.09 0.11 -0.11 -0.15 0.00 -0.06 -0.03 -0.10 0.09 0.47
0.04 0.02 -0.01 -0.17 -0.11 -0.24 -0.03 0.16 0.29 0.26
-0.12 -0.01 -0.13 -0.08 -0.01 -0.08 -0.01 0.09 0.18 0.38
0.05 -0.04 0.04 -0.04 -0.13 -0.14 -0.03 -0.19 -0.01 0.28
-0.15 0.04 -0.12 -0.35 -0.21 0.22 0.09 -0.03 0.07 0.15
-0.12 -0.12 -0.09 0.10 0.08 -0.02 0.05 0.21 0.51 0.91
-0.04 -0.01 -0.16 -0.12 -0.05 0.05 0.14 0.29 0.49 0.33
-0.10 -0.15 -0.14 -0.10 0.06 -0.02 0.12 0.26 0.19 0.16
-0.30 -0.22 -0.10 -0.06 0.00 0.08 -0.02 0.00 0.08 0.19
0.12 -0.19 -0.16 -0.08 -0.07 0.14 0.00 -0.12 0.01 0.07
-0.04 -0.13 -0.17 -0.12 0.00 0.12 -0.01 -0.10 -0.07 -0.16
-0.17 -0.19 -0.08 -0.07 -0.19 0.01 -0.01 0.05 -0.05 -0.05
-0.27 -0.22 -0.03 0.10 -0.11 -0.03 0.03 0.06 -0.02 0.10
-0.15 -0.10 -0.11 -0.02 0.06 -0.28 -0.09 0.07 0.03 0.00
-0.11 -0.05 -0.27 -0.22 0.01 0.20 -0.16 -0.06 0.00 0.03
-0.05 -0.16 -0.22 0.01 -0.07 -0.02 0.03 -0.04 0.08 -0.01
-0.03 0.02 -0.05 -0.09 0.06 -0.20 -0.05 0.06 -0.04 0.08
0.11 -0.12 -0.14 -0.23 -0.11 0.15 -0.16 -0.08 0.04 -0.01
-0.20 -0.32 0.10 -0.04 -0.40 -0.06 -0.04 -0.12 0.06 -0.01

Chart 40.—Wind stress curl for April.

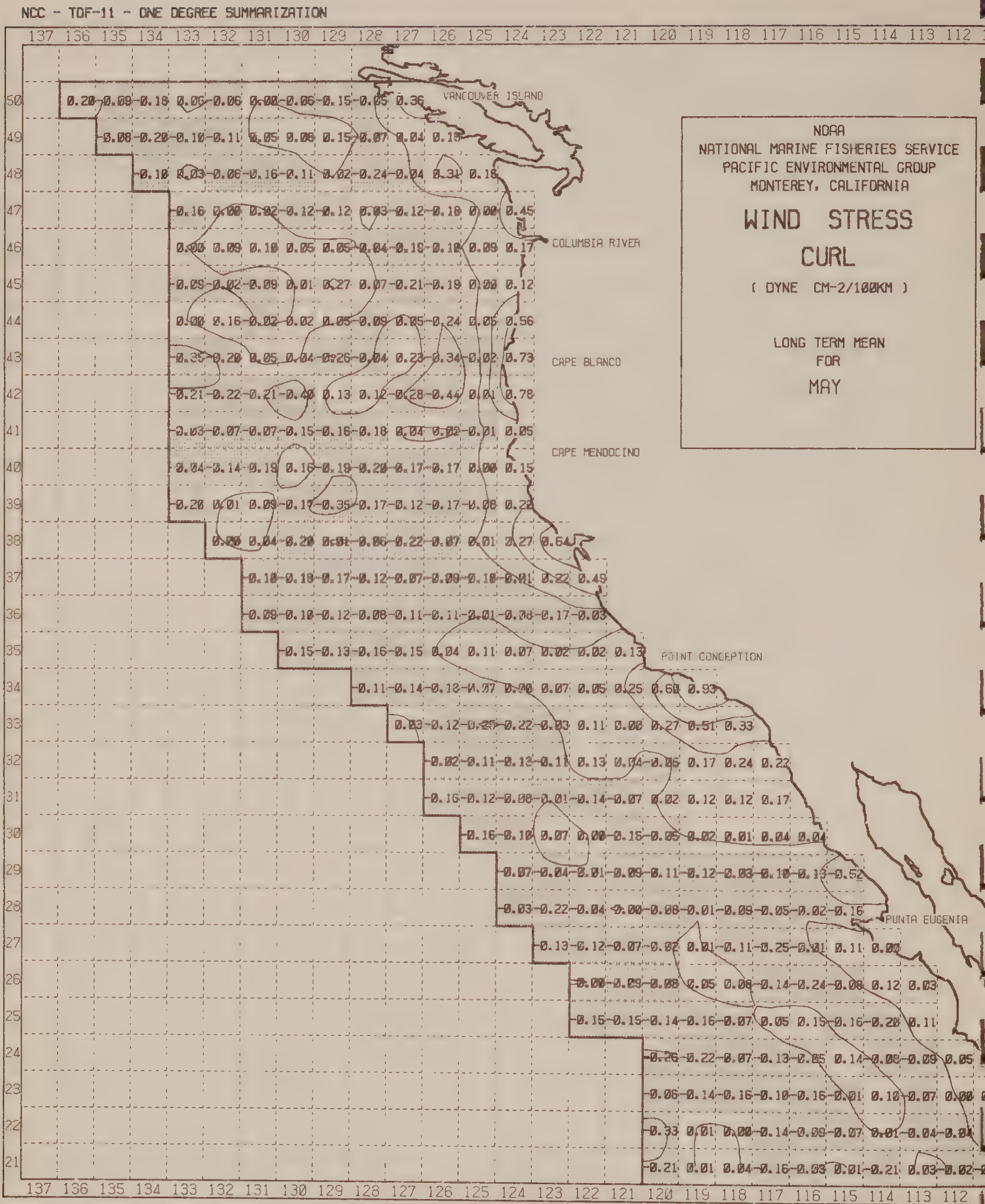

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 0.20-0.09-0.18 0.06-0.06 0.00-0.06-0.15-0.05 0.36
49 -0.08-0.20-0.10-0.11 0.05 0.08 0.15-0.07 0.04 0.15
48 -0.10 0.03-0.06-0.16-0.11 0.02-0.24-0.04 0.31 0.16
47 -0.16 0.00 0.02-0.12-0.12 0.03-0.12-0.10 0.00 0.45
46 0.00 0.09 0.10 0.05 0.05-0.04-0.19-0.10 0.09 0.17
45 -0.09-0.02-0.09 0.01 0.27 0.07-0.21-0.19 0.00 0.12
44 0.00 0.16-0.02 0.02 0.05-0.09 0.05-0.24 0.05 0.56
43 -0.35-0.20 0.05 0.04-0.26-0.04 0.23-0.34-0.02 0.73
42 -0.21-0.22-0.21-0.40 0.13 0.12-0.28-0.44 0.01 0.78
41 -0.03-0.07-0.07-0.15-0.16-0.18 0.04 0.02-0.01 0.05
40 -0.04-0.14-0.19 0.16-0.19-0.20-0.17-0.17 0.00 0.15
39 -0.20 0.01 0.09-0.17-0.35-0.17-0.12-0.17-0.08 0.22
38 0.00 0.04-0.20 0.01-0.06-0.22-0.07 0.01 0.27 0.64
37 -0.10-0.10-0.17-0.12-0.07-0.09-0.18-0.01 0.22 0.49
36 -0.09-0.10-0.12-0.08-0.11-0.11-0.01-0.08-0.17-0.03
35 -0.15-0.13-0.16-0.15 0.04 0.11 0.07 0.02 0.02 0.13
34 -0.11-0.14-0.12-0.07 0.00 0.07 0.05 0.25 0.60 0.93
33 0.03-0.12-0.25-0.22-0.03 0.11 0.00 0.27 0.51 0.33
32 -0.02-0.11-0.12-0.11 0.13 0.04-0.05 0.17 0.24 0.22
31 -0.16-0.12-0.08-0.01-0.14-0.07 0.02 0.12 0.12 0.17
30 -0.16-0.10 0.07 0.00-0.16-0.05 0.02 0.01 0.04 0.04
29 -0.07-0.04-0.01-0.09-0.11-0.12-0.03-0.10-0.13-0.52
28 -0.03-0.22-0.04-0.00-0.08-0.01-0.09-0.05-0.02-0.16
27 -0.13-0.12-0.07-0.02 0.01-0.11-0.25-0.01 0.11 0.02
26 -0.00-0.09-0.08 0.05 0.08-0.14-0.24-0.08 0.12 0.03
25 -0.15-0.15-0.14-0.16-0.07 0.05 0.15-0.16-0.20 0.11
24 -0.26-0.22-0.07-0.13-0.05 0.14-0.08-0.09 0.05
23 -0.06-0.14-0.16-0.10-0.16-0.01 0.10-0.07 0.00
22 -0.33 0.01 0.00-0.14-0.09-0.07 0.01-0.04-0.04
21 -0.21 0.01 0.04-0.16-0.03 0.01-0.21 0.03-0.02
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
MAY

Chart 41.—Wind stress curl for May.

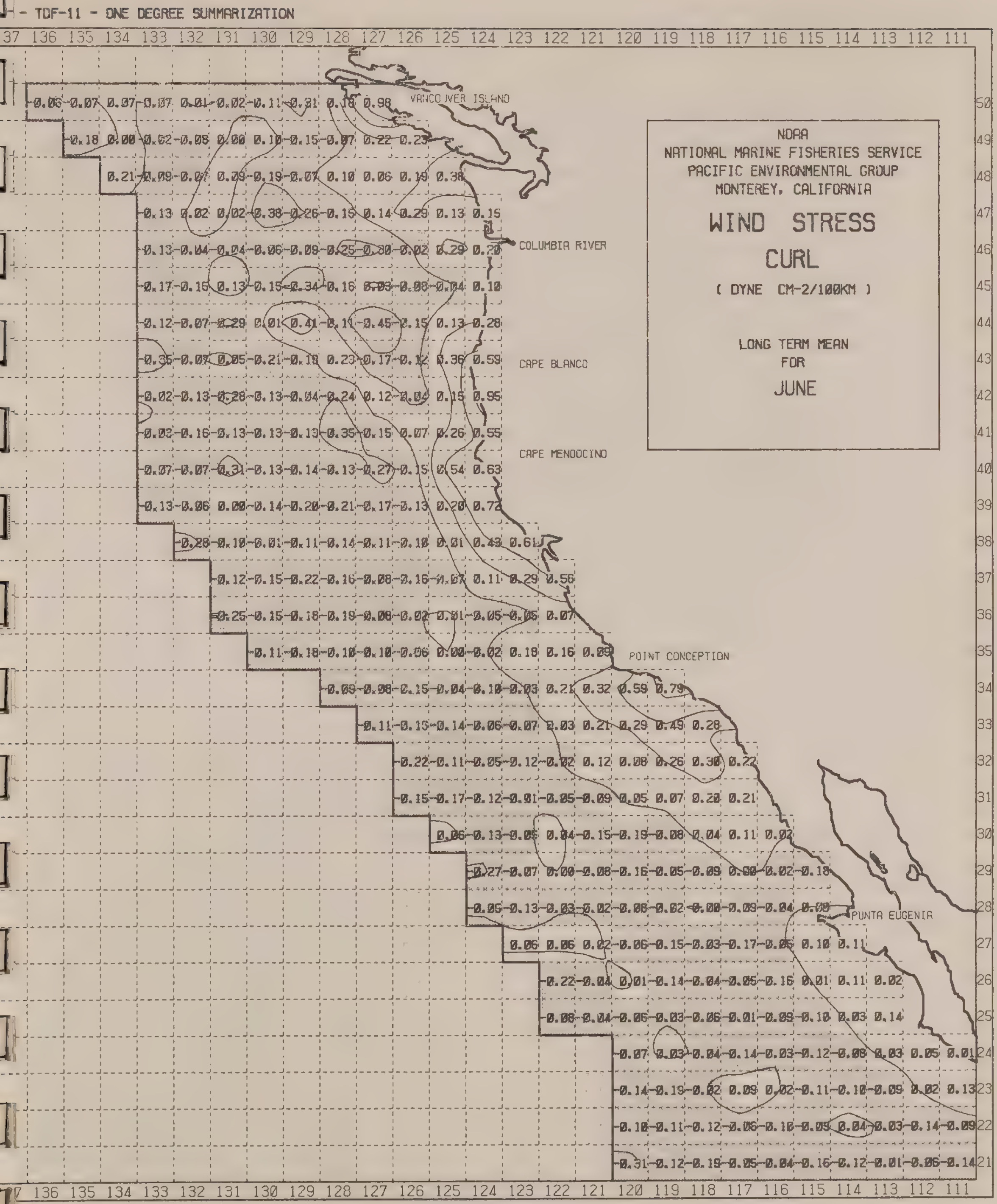

TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
JUNE
-0.06 -0.07 0.07 -0.07 0.01 -0.02 -0.11 -0.31 0.18 0.98
-0.18 0.00 -0.02 -0.08 0.00 0.10 -0.15 -0.07 0.22 -0.23
0.21 -0.09 -0.07 0.29 -0.19 -0.07 0.10 0.06 0.19 0.38
-0.13 0.02 0.02 -0.38 -0.26 -0.15 0.14 -0.29 0.13 0.15
-0.13 -0.04 -0.04 -0.06 -0.09 -0.25 -0.30 -0.02 0.29 0.20
-0.17 -0.15 0.13 -0.15 -0.34 -0.16 0.03 -0.08 -0.04 0.10
-0.12 -0.07 -0.29 0.01 0.41 -0.11 -0.45 -0.15 0.13 0.28
-0.35 -0.07 0.05 -0.21 -0.18 0.23 -0.17 -0.12 0.36 0.59
-0.02 -0.13 -0.28 -0.13 -0.04 -0.24 0.12 -0.04 0.15 0.95
-0.02 -0.16 -0.13 -0.13 -0.13 -0.35 -0.15 0.07 0.26 0.55
-0.07 -0.07 -0.31 -0.13 -0.14 -0.13 -0.27 -0.15 0.54 0.63
-0.13 -0.06 0.00 -0.14 -0.20 -0.21 -0.17 -0.13 0.20 0.72
-0.28 -0.10 -0.01 -0.11 -0.14 -0.11 -0.10 0.01 0.43 0.61
-0.12 -0.15 -0.22 -0.16 -0.08 -0.16 -0.07 0.11 0.29 0.56
-0.25 -0.15 -0.18 -0.19 -0.08 -0.02 0.01 -0.05 -0.05 0.07
-0.11 -0.18 -0.10 -0.10 -0.06 0.00 -0.02 0.18 0.16 0.09
-0.09 -0.08 -0.15 -0.04 -0.10 -0.03 0.21 0.32 0.59 0.79
-0.11 -0.15 -0.14 -0.06 -0.07 0.03 0.21 0.29 0.49 0.28
-0.22 -0.11 -0.05 -0.12 -0.02 0.12 0.08 0.26 0.30 0.22
-0.15 -0.17 -0.12 -0.01 -0.05 -0.09 0.05 0.07 0.20 0.21
0.06 -0.13 -0.05 0.04 -0.15 -0.19 -0.08 0.04 0.11 0.02
-0.27 -0.07 0.00 -0.08 -0.16 -0.05 -0.09 0.00 -0.02 -0.18
-0.05 -0.13 -0.03 -0.02 -0.08 -0.02 -0.00 -0.09 -0.04 0.08
0.06 0.06 0.02 -0.06 -0.15 -0.03 -0.17 -0.05 0.10 0.11
-0.22 -0.04 0.01 -0.14 -0.04 -0.05 -0.16 0.01 0.11 0.02
-0.08 -0.04 -0.06 -0.03 -0.06 -0.01 -0.09 -0.10 0.03 0.14
-0.07 0.03 -0.04 -0.14 -0.03 -0.12 -0.08 0.03 0.05 0.01
-0.14 -0.19 -0.02 0.09 0.02 -0.11 -0.10 -0.09 0.02 0.13
-0.10 -0.11 -0.12 -0.06 -0.10 -0.09 0.04 -0.03 -0.14 -0.09
-0.31 -0.12 -0.19 -0.05 -0.04 -0.16 -0.12 -0.01 -0.06 -0.14

Chart 42.—Wind stress curl for June.

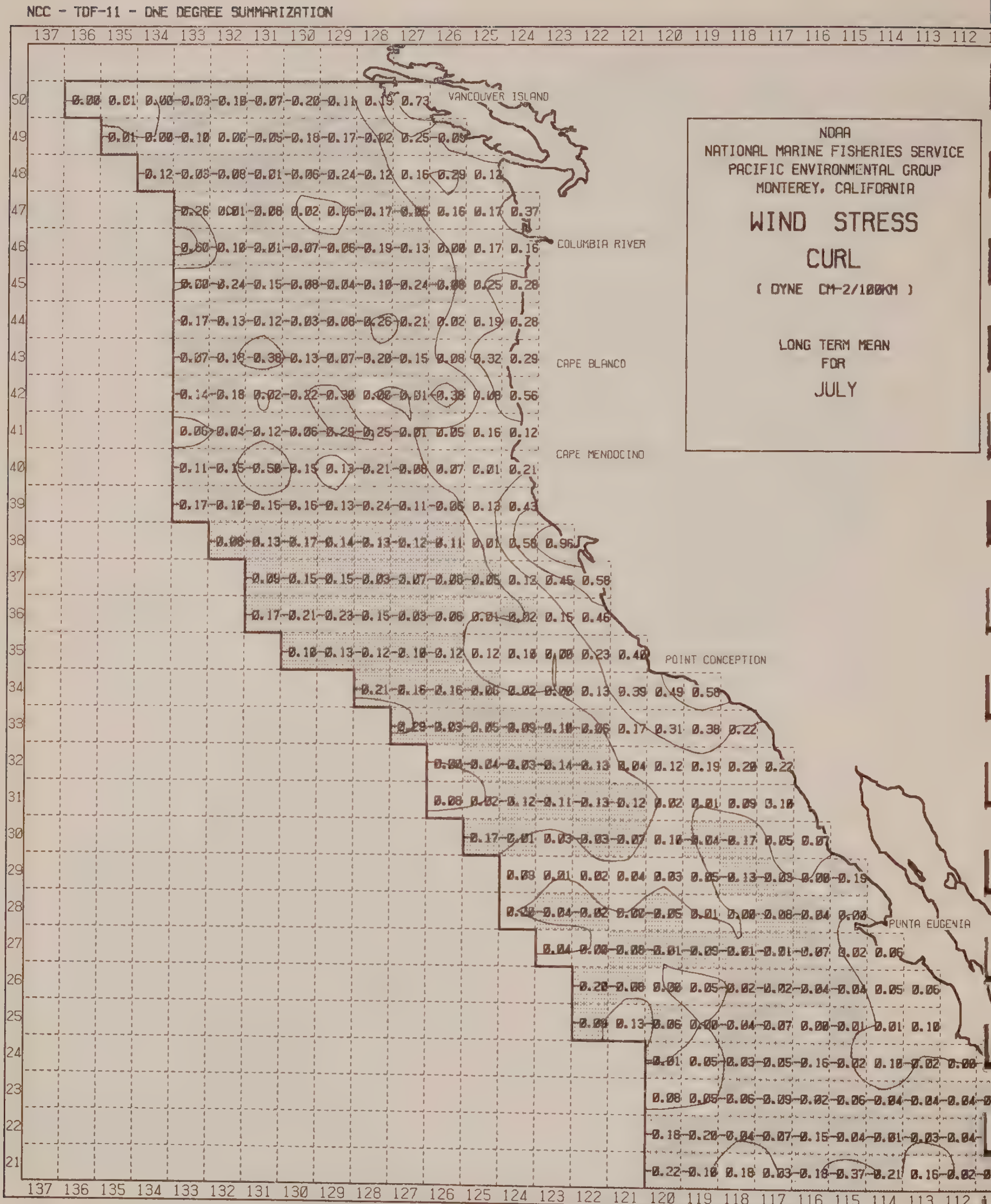

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 -0.00 0.01 0.00-0.03-0.10-0.07-0.20-0.11 0.19 0.73
49 -0.01-0.00-0.10 0.00-0.05-0.18-0.17-0.02 0.25-0.09
48 -0.12-0.03-0.08-0.01-0.06-0.24-0.12 0.16 0.29 0.12
47 -0.26 0.01-0.08 0.02 0.06-0.17-0.05 0.16 0.17 0.37
46 -0.60-0.10-0.01-0.07-0.06-0.19-0.13 0.00 0.17 0.16
45 -0.00-0.24-0.15-0.08-0.04-0.10-0.24-0.00 0.25 0.28
44 -0.17-0.13-0.12-0.03-0.08-0.26-0.21 0.02 0.19 0.28
43 -0.07-0.10-0.38-0.13-0.07-0.20-0.15 0.08 0.32 0.29
42 -0.14-0.18 0.02-0.22-0.30 0.00-0.01-0.38 0.00 0.56
41 0.06-0.04-0.12-0.06-0.29-0.25-0.01 0.05 0.16 0.12
40 -0.11-0.15-0.50-0.15 0.13-0.21-0.08 0.07 0.01 0.21
39 -0.17-0.10-0.15-0.16-0.13-0.24-0.11-0.06 0.13 0.43
38 -0.08-0.13-0.17-0.14-0.13-0.12-0.11 0.01 0.58 0.96
37 -0.09-0.15-0.15-0.03-0.07-0.08-0.05 0.12 0.45 0.58
36 -0.17-0.21-0.23-0.15-0.03-0.06 0.01-0.02 0.15 0.46
35 -0.10-0.13-0.12-0.10-0.12 0.12 0.10 0.00 0.23 0.40
34 -0.21-0.16-0.16-0.06 0.02 0.00 0.13 0.39 0.49 0.58
33 -0.29-0.03-0.05-0.09-0.10-0.06 0.17 0.31 0.38 0.22
32 -0.00-0.04-0.03-0.14-0.13 0.04 0.12 0.19 0.20 0.22
31 0.08 0.02-0.12-0.11-0.13-0.12 0.02 0.01 0.09 0.10
30 -0.17-0.01 0.03-0.03-0.07 0.10-0.04-0.17 0.05 0.07
29 0.09 0.01 0.02 0.04 0.03 0.05-0.13-0.03-0.00-0.19
28 0.00-0.04-0.02 0.00-0.05 0.01 0.00-0.08-0.04 0.00
27 0.04 0.00-0.08-0.01-0.09-0.01-0.01-0.07 0.02 0.06
26 -0.20-0.08 0.00 0.05-0.02-0.02-0.04-0.04 0.05 0.06
25 -0.09 0.13-0.06 0.00-0.04-0.07 0.00-0.01 0.01 0.10
24 -0.01 0.05-0.03-0.05-0.16-0.02 0.10-0.02 0.00-
23 0.08 0.05-0.06-0.09-0.02-0.06-0.04-0.04-0.04-
22 -0.18-0.20-0.04-0.07-0.15-0.04-0.01-0.03-0.04-
21 -0.22-0.10 0.18 0.03-0.18-0.37-0.21 0.16-0.02-
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
JULY

Chart 43.—Wind stress curl for July.

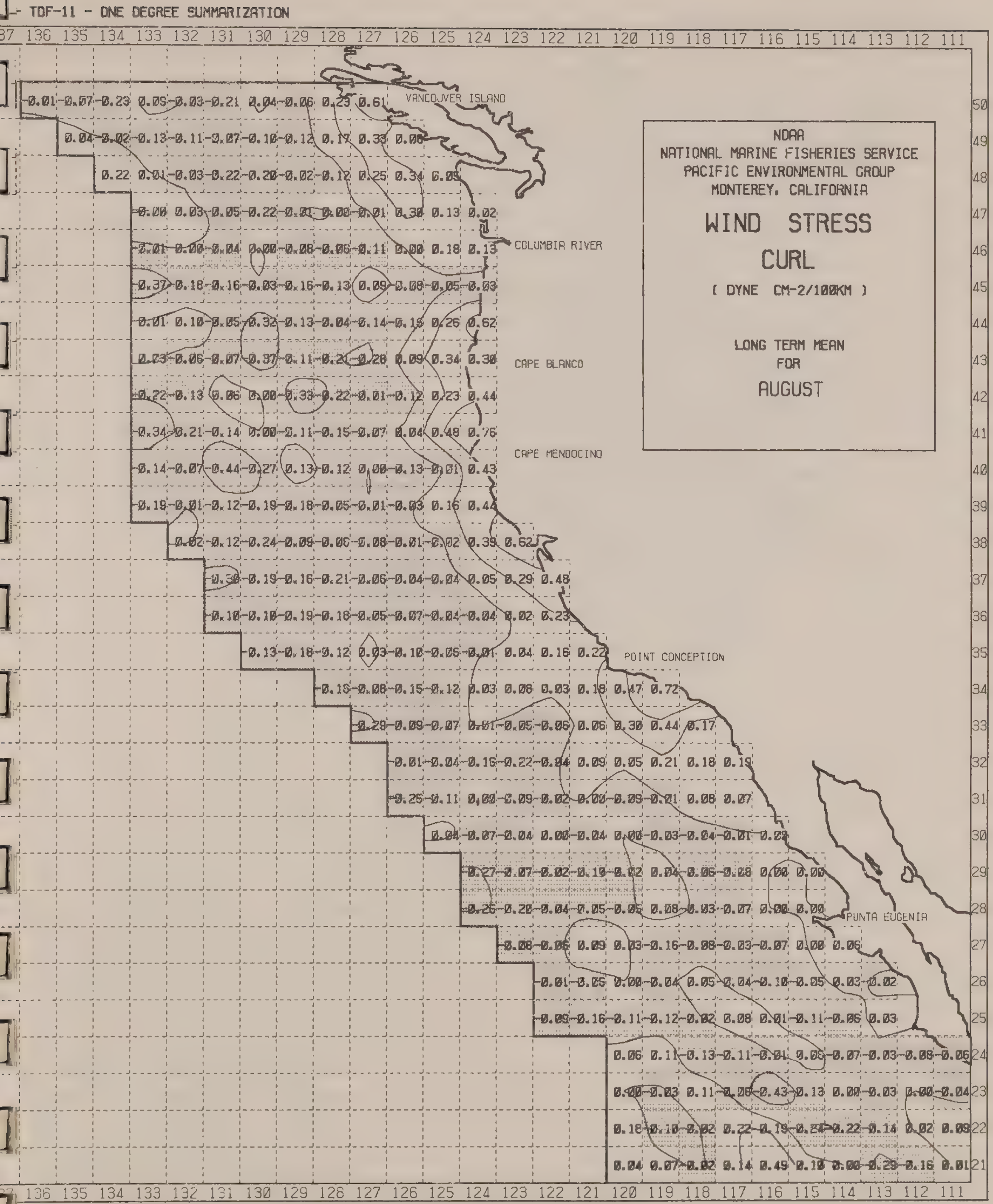

TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
AUGUST
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 -0.01-0.07-0.23 0.05-0.03-0.21 0.04-0.06 0.23 0.61
49 0.04-0.02-0.13-0.11-0.07-0.10-0.12 0.17 0.33 0.08
48 0.22 0.01-0.03-0.22-0.20-0.02-0.12 0.25 0.34 0.05
47 -0.00 0.03-0.05-0.22-0.01 0.00-0.01 0.30 0.13 0.02
46 -0.01 0.00-0.04 0.00-0.08-0.06-0.11 0.00 0.18 0.13
45 -0.37-0.18-0.16-0.03-0.16-0.13 0.09-0.08-0.05-0.03
44 -0.01 0.10-0.05-0.32-0.13-0.04-0.14-0.15 0.26 0.62
43 0.03-0.06-0.07-0.37-0.11-0.21-0.28 0.09 0.34 0.30
42 -0.22-0.13 0.06 0.00-0.33-0.22-0.01-0.12 0.23 0.44
41 -0.34-0.21-0.14 0.00-0.11-0.15-0.07 0.04 0.48 0.76
40 -0.14-0.07-0.44-0.27 0.13-0.12 0.00-0.13-0.01 0.43
39 -0.19-0.01-0.12-0.19-0.18-0.05-0.01-0.03 0.16 0.44
38 -0.02-0.12-0.24-0.09-0.06-0.08-0.01-0.02 0.39 0.62
37 -0.30-0.19-0.16-0.21-0.06-0.04-0.04 0.05 0.29 0.48
36 -0.10-0.10-0.19-0.18-0.05-0.07-0.04-0.04 0.02 0.23
35 -0.13-0.18-0.12 0.03-0.10-0.06-0.01 0.04 0.16 0.22
34 -0.15-0.08-0.15-0.12 0.03 0.08 0.03 0.18 0.47 0.72
33 -0.29-0.09-0.07 0.01-0.05-0.06 0.06 0.30 0.44 0.17
32 -0.01-0.04-0.16-0.22-0.04 0.09 0.05 0.21 0.18 0.19
31 -0.25-0.11 0.00-0.09-0.02-0.00-0.09-0.01 0.08 0.07
30 0.04-0.07-0.04 0.00-0.04 0.00-0.03-0.04-0.01 0.02
29 -0.27-0.07-0.02-0.19-0.02 0.04-0.06-0.08 0.00 0.00
28 -0.26-0.20-0.04-0.05-0.05 0.08-0.03-0.07 0.00 0.00
27 -0.08-0.06 0.09 0.03-0.16-0.08-0.03-0.07 0.00 0.06
26 -0.01-0.05 0.00-0.04 0.05-0.04-0.10-0.05 0.03-0.02
25 -0.09-0.16-0.11-0.12-0.02 0.08 0.01-0.11-0.06 0.03
24 0.06 0.11-0.13-0.11-0.01 0.08-0.07-0.03-0.08-0.06
23 0.00-0.03 0.11-0.08-0.43-0.13 0.00-0.03 0.00-0.04
22 0.18-0.10-0.02 0.22-0.19-0.24-0.22-0.14 0.02 0.09
21 0.04 0.07-0.02 0.14 0.49 0.19 0.00-0.29-0.16 0.01
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 44.—Wind stress curl for August.

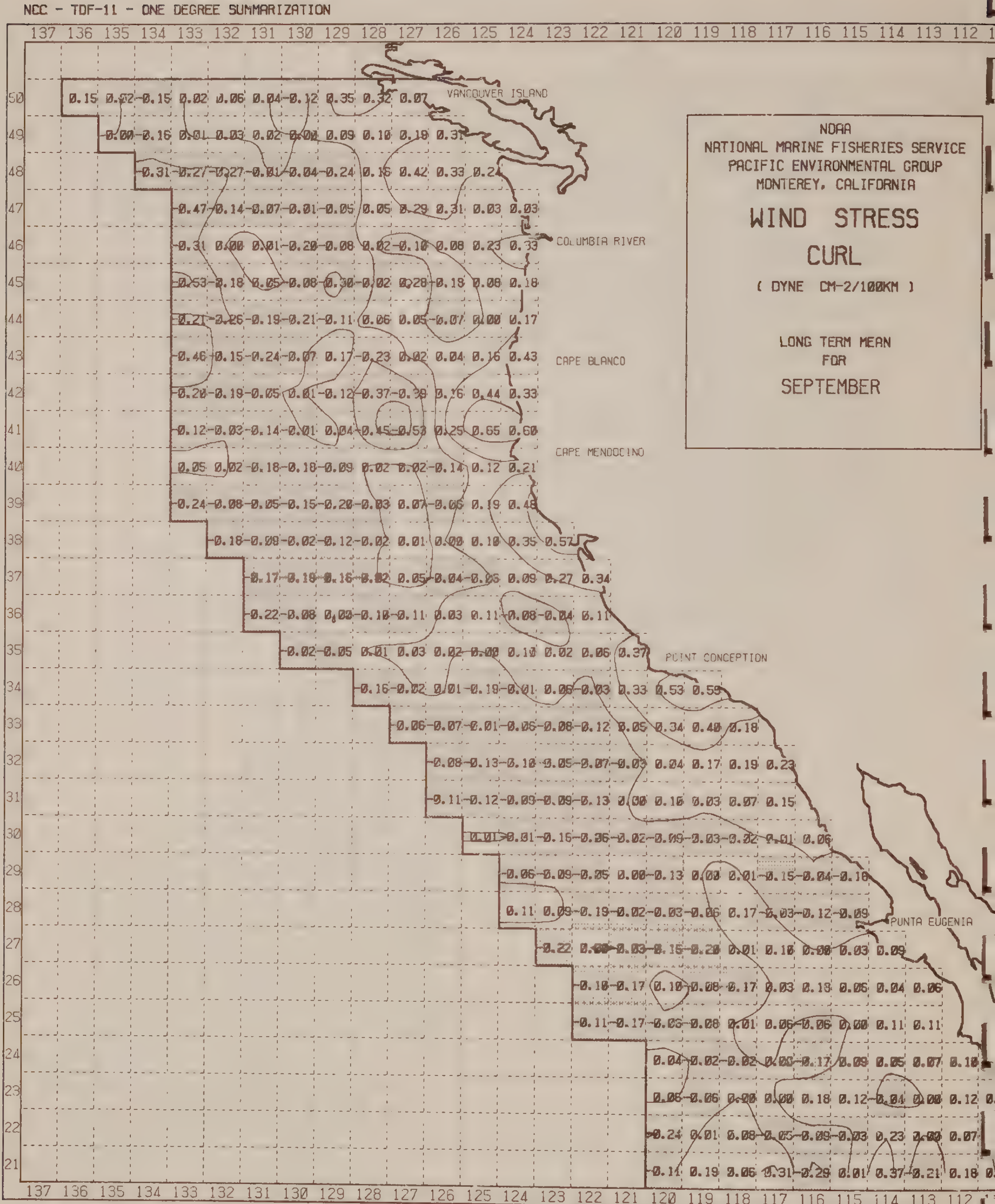

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
SEPTEMBER
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
0.15 0.02 -0.15 0.02 0.06 0.04 -0.12 0.35 0.32 0.07
-0.00 -0.16 0.01 0.03 0.02 0.00 0.09 0.10 0.19 0.31
-0.31 -0.27 -0.27 -0.01 -0.04 -0.24 0.16 0.42 0.33 0.24
-0.47 -0.14 -0.07 -0.01 -0.05 0.05 0.29 0.31 0.03 0.03
-0.31 0.00 0.01 -0.20 -0.08 0.02 -0.10 0.08 0.23 0.33
-0.53 -0.18 0.05 -0.08 -0.30 -0.02 0.28 -0.18 0.06 0.18
-0.21 -0.26 -0.19 -0.21 -0.11 0.06 0.05 -0.07 0.00 0.17
-0.46 -0.15 -0.24 -0.07 0.17 -0.23 0.02 0.04 0.16 0.43
-0.20 -0.19 -0.05 -0.01 -0.12 -0.37 -0.39 0.16 0.44 0.33
-0.12 -0.03 -0.14 -0.01 0.04 -0.45 -0.53 0.25 0.65 0.60
0.05 0.02 -0.18 -0.18 -0.09 0.02 0.02 -0.14 0.12 0.21
-0.24 -0.08 -0.05 -0.15 -0.20 -0.03 0.07 -0.06 0.19 0.48
-0.18 -0.09 -0.02 -0.12 -0.02 0.01 0.00 0.10 0.35 0.57
-0.17 -0.19 -0.16 -0.02 0.05 -0.04 -0.05 0.09 0.27 0.34
-0.22 -0.08 0.00 -0.10 -0.11 0.03 0.11 -0.08 -0.04 0.11
-0.02 -0.05 0.01 0.03 0.02 0.00 0.10 0.02 0.06 0.37
-0.16 -0.02 0.01 -0.19 -0.01 0.06 -0.03 0.33 0.53 0.59
-0.06 -0.07 -0.01 -0.06 -0.08 -0.12 0.05 0.34 0.40 0.18
-0.08 -0.13 -0.10 -0.05 -0.07 -0.03 0.04 0.17 0.19 0.23
-0.11 -0.12 -0.09 -0.09 -0.13 0.00 0.10 0.03 0.07 0.15
-0.01 -0.01 -0.16 -0.06 -0.02 -0.09 -0.03 -0.02 -0.01 0.06
-0.06 -0.09 -0.05 0.00 -0.13 0.00 0.01 -0.15 -0.04 -0.10
0.11 0.09 -0.19 -0.02 -0.03 -0.06 0.17 -0.03 -0.12 -0.09
-0.22 0.00 -0.03 -0.16 -0.20 0.01 0.10 0.00 0.03 0.09
-0.10 -0.17 0.10 -0.08 -0.17 0.03 0.13 0.06 0.04 0.06
-0.11 -0.17 -0.06 -0.08 0.01 0.06 -0.06 0.00 0.11 0.11
0.04 -0.02 -0.02 0.00 -0.17 0.09 0.05 0.07 0.10
0.06 -0.06 0.00 0.00 0.18 0.12 -0.04 0.00 0.12
-0.24 0.01 0.08 -0.05 -0.09 -0.03 0.23 0.00 0.07
-0.11 0.19 0.06 -0.31 -0.29 0.01 0.37 -0.21 0.18

Chart 45.—Wind stress curl for September.

TDF-11 - ONE DEGREE SUMMARIZATION

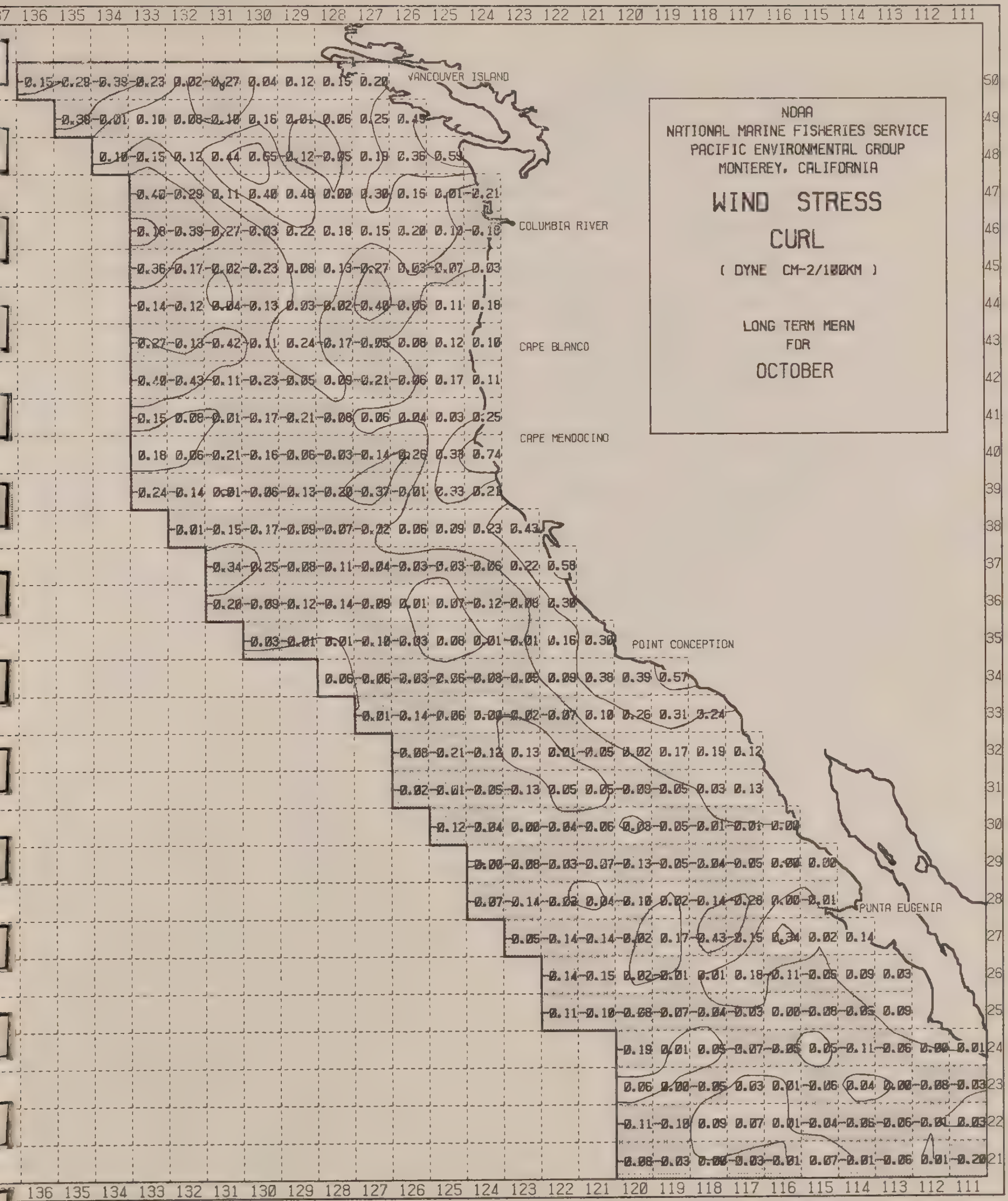

NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
OCTOBER
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
-0.15 -0.28 -0.38 -0.23 0.02 -0.27 0.04 0.12 0.15 0.20
-0.38 -0.01 0.10 0.08 -0.10 0.16 0.01 0.06 0.25 0.45
0.10 -0.15 0.12 0.44 0.65 -0.12 -0.05 0.19 0.36 0.59
-0.40 -0.29 0.11 0.40 0.48 0.00 0.30 0.15 0.01 -0.21
-0.18 -0.39 -0.27 -0.03 0.22 0.18 0.15 0.20 0.10 -0.10
-0.36 -0.17 -0.02 -0.23 0.08 0.13 -0.27 0.03 -0.07 0.03
-0.14 -0.12 0.04 -0.13 0.03 -0.02 -0.40 -0.06 0.11 0.18
-0.27 -0.13 -0.42 0.11 0.24 -0.17 -0.05 0.08 0.12 0.10
-0.40 -0.43 -0.11 -0.23 -0.05 0.09 -0.21 -0.06 0.17 0.11
-0.15 0.08 -0.01 -0.17 -0.21 -0.08 0.06 0.04 0.03 0.25
0.18 0.06 -0.21 -0.16 -0.06 -0.03 -0.14 0.26 0.38 0.74
-0.24 -0.14 0.01 -0.06 -0.13 -0.20 -0.37 -0.01 0.33 0.21
-0.01 -0.15 -0.17 -0.09 -0.07 -0.22 0.06 0.09 0.23 0.43
-0.34 -0.25 -0.08 -0.11 -0.04 -0.03 -0.03 -0.06 0.22 0.58
-0.20 -0.09 -0.12 -0.14 -0.09 0.01 0.07 -0.12 -0.08 0.30
-0.03 -0.01 0.01 -0.10 -0.03 0.08 0.01 -0.01 0.16 0.30
0.06 -0.06 -0.03 -0.06 -0.08 -0.05 0.09 0.38 0.39 0.57
-0.01 -0.14 -0.06 0.00 -0.02 -0.07 0.10 0.26 0.31 0.24
-0.08 -0.21 -0.12 0.13 0.01 -0.05 0.02 0.17 0.19 0.12
-0.02 -0.01 -0.05 -0.13 0.05 0.05 -0.09 -0.05 0.03 0.13
-0.12 -0.04 0.00 -0.04 -0.06 0.08 -0.05 -0.01 -0.01 0.00
-0.00 -0.08 -0.03 -0.07 -0.13 -0.05 -0.04 -0.05 0.00 0.00
-0.07 -0.14 -0.03 0.04 -0.10 0.02 -0.14 -0.28 0.00 -0.01
-0.05 -0.14 -0.14 -0.02 0.17 -0.43 -0.15 0.34 0.02 0.14
-0.14 -0.15 0.02 -0.01 0.01 0.18 -0.11 -0.05 0.09 0.03
-0.11 -0.10 -0.08 -0.07 -0.04 -0.03 0.00 -0.08 -0.05 0.09
-0.19 0.01 0.05 -0.07 -0.05 0.05 -0.11 -0.06 0.00 0.01
0.06 0.00 -0.05 0.03 0.01 -0.06 0.04 0.00 -0.08 -0.03
-0.11 -0.10 0.09 0.07 0.01 -0.04 -0.05 -0.06 -0.01 0.03
-0.08 -0.03 0.00 -0.03 -0.01 0.07 -0.01 -0.06 0.01 -0.20

Chart 46.—Wind stress curl for October.

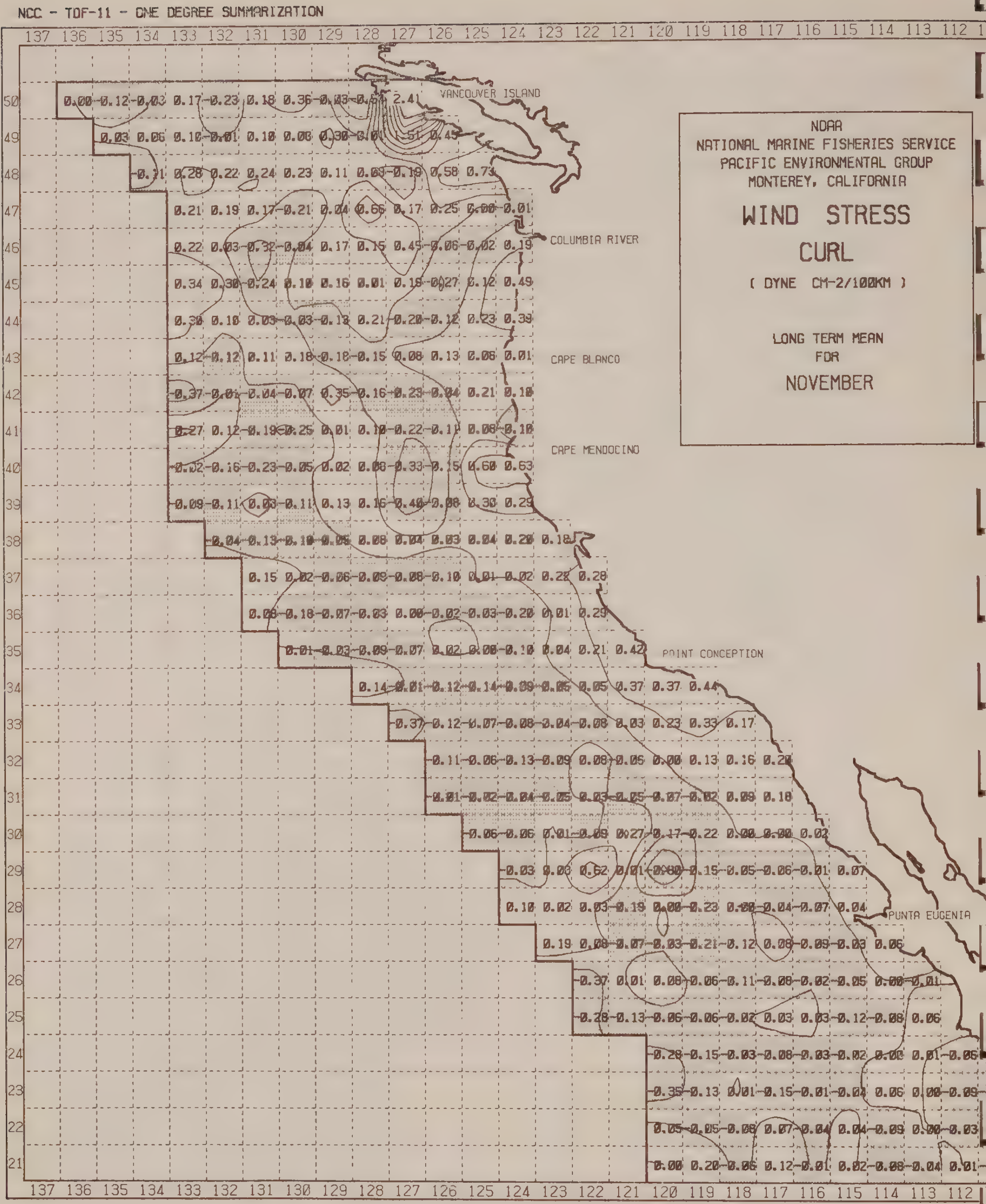

NCC - TDF-11 - ONE DEGREE SUMMARIZATION
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
NOVEMBER
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21

Chart 47.—Wind stress curl for November.

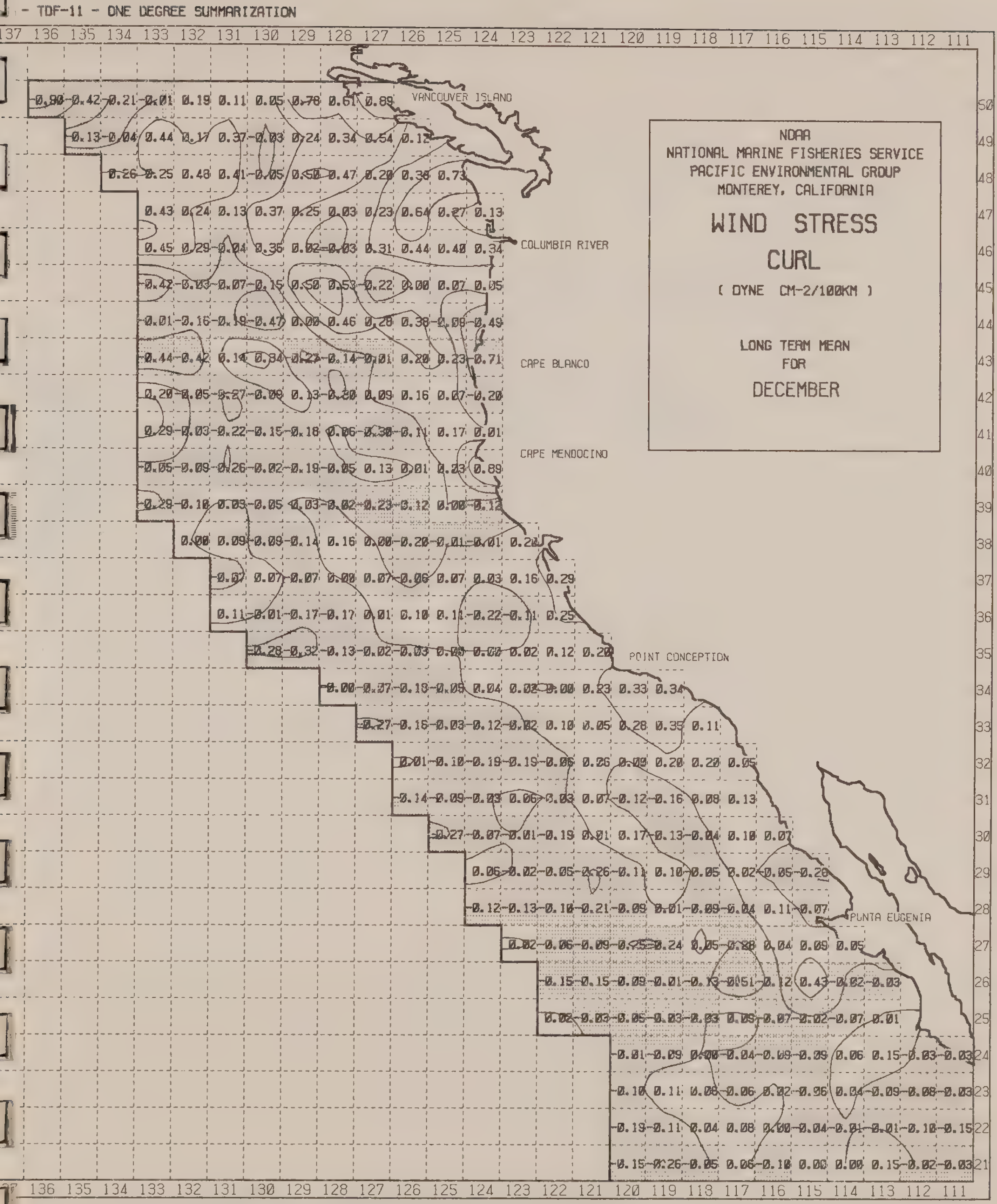

- TDF-11 - ONE DEGREE SUMMARIZATION
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
NOAA
NATIONAL MARINE FISHERIES SERVICE
PACIFIC ENVIRONMENTAL GROUP
MONTEREY, CALIFORNIA
WIND STRESS
CURL
(DYNE CM-2/100KM)
LONG TERM MEAN
FOR
DECEMBER
VANCOUVER ISLAND
COLUMBIA RIVER
CAPE BLANCO
CAPE MENDOCINO
POINT CONCEPTION
PUNTA EUGENIA
-0.80-0.42-0.21-0.01 0.19 0.11 0.05 0.78 0.61 0.89
-0.13-0.04 0.44 0.17 0.37-0.03 0.24 0.34 0.54 0.12
0.26-0.25 0.48 0.41-0.05 0.50 0.47 0.20 0.38 0.73
0.43 0.24 0.13 0.37 0.25 0.03 0.23 0.64 0.27 0.13
0.45 0.29-0.04 0.35 0.02-0.03 0.31 0.44 0.40 0.34
-0.42-0.03-0.07-0.15 0.50 0.53-0.22 0.00 0.07 0.05
-0.01-0.16-0.19-0.47 0.00 0.46 0.28 0.38-0.08-0.49
-0.44-0.42 0.14 0.84-0.23-0.14-0.01 0.20 0.23-0.71
0.20-0.05-0.27-0.09 0.13-0.20 0.09 0.16 0.07-0.20
0.29-0.03-0.22-0.15-0.18 0.06-0.30-0.11 0.17 0.01
-0.05-0.09-0.26-0.02-0.19-0.05 0.13 0.01 0.23 0.89
-0.29-0.10 0.03-0.05 0.03-0.02-0.23-0.12 0.00-0.12
0.00 0.09-0.09-0.14 0.16 0.00-0.20-0.01-0.01 0.22
-0.07 0.07-0.07 0.00 0.07-0.06 0.07 0.03 0.16 0.29
0.11-0.01-0.17-0.17 0.01 0.10 0.11-0.22-0.11 0.25
-0.28-0.32-0.13-0.02-0.03 0.00-0.00 0.02 0.12 0.20
-0.00-0.37-0.18-0.05 0.04 0.02-0.00 0.23 0.33 0.34
-0.27-0.16-0.03-0.12-0.02 0.10 0.05 0.28 0.35 0.11
0.01-0.10-0.19-0.19-0.06 0.26 0.09 0.20 0.20 0.05
-0.14-0.09-0.03 0.06-0.03 0.07-0.12-0.16 0.08 0.13
-0.27-0.07-0.01-0.19 0.01 0.17-0.13-0.04 0.10 0.07
0.06-0.02-0.05-0.26-0.11 0.10-0.05 0.02-0.05-0.20
-0.12-0.13-0.10-0.21-0.09 0.01-0.09-0.04 0.11-0.07
0.02-0.06-0.09-0.75-0.24 0.05-0.28 0.04 0.09 0.05
-0.15-0.15-0.09-0.01-0.13-0.51-0.12 0.43-0.02-0.03
0.02-0.03-0.05-0.03-0.03 0.09-0.07-0.02-0.07 0.01
-0.01-0.09 0.00-0.04-0.09-0.09 0.06 0.15-0.03-0.03
-0.10 0.11 0.08-0.06 0.02-0.36 0.04-0.09-0.08-0.03
-0.19-0.11 0.04 0.08 0.00-0.04-0.01-0.01-0.10-0.15
-0.15-0.26-0.05 0.06-0.10 0.00 0.00 0.15-0.02-0.03
137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111

Chart 48.—Wind stress curl for December.

☆GPO 798-349

NOAA Technical Report NMFS SSRF-715

Bottom Obstructions in the Southwestern North Atlantic, Gulf of Mexico, and Caribbean Sea

G. Michael Russell, Abraham J. Barrett,
L. Steve Sarbeck, and John H. Wordlaw

September 1977

U.S. DEPARTMENT OF COMMERCE
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Bottom Obstructions in the Southwestern North Atlantic, Gulf of Mexico, and Caribbean Sea[1]

G. MICHAEL RUSSELL, ABRAHAM J. BARRETT, L. STEVE SARBECK,
and JOHN H. WORDLAW[2]

ABSTRACT

Lists of bottom obstructions are provided to aid in avoiding potential hazards to fishing gear. Locations, depth, gear type, and damage received are included. Within the regions, the following numbers of obstructions are identified: 267 southeastern North America, 320 Gulf of Mexico, 23 West Indies, 119 Caribbean Sea, and 59 northeast coast of South America.

INTRODUCTION

age to fishing gear from bottom obstructions is
in lost time and gear replacement or repair. To ef-
vely reduce gear damage, fishermen keep their own
of obstructions encountered during fishing
ons, but few of these personal records have been
shed. There are two additional sources for infor-
on on obstructions: Graham (1975) and the Ob-
on Commission, Gulf State Marine Fisheries
ssion, New Orleans, La.

ce 1950 the National Marine Fisheries Service (for-
Bureau of Commercial Fisheries) had located 788
ctions during research cruises. This report
s fishermen, operating in the southwestern North
tic and adjacent areas, with locations of these ob-
ons. However, no attempt has been made to iden-
m.

DATA FORMAT

southwestern North Atlantic has been divided
five regions to help find these obstructions: 1)
eastern North America, 2) Gulf of Mexico, 3) West
4) Caribbean Sea, and 5) northeastern South
a.

vision between these regions is based on latitude and
de, and major geographical features that form
boundaries (Fig. 1). The location of obstructions
these five regions is arranged from north to south
ude) or east to west (longitude), depending on a
an's orientation to the shoreline. Locations
regions 2 (Gulf of Mexico), 3 (West Indies), and 4
bbean Sea) are listed from east to west (increasing
ude); locations within regions 1 (southeastern North America) and 5 (northeastern South America) are listed from north to south (decreasing latitude).

Information on depth, gear, and damage is also provided. Loran positions are included for those areas where readings are considered reliable.

APPLICATION

The area to be fished can be identified from the orientation chart (Fig. 1). If fishing is to be conducted in the Gulf of Mexico (region 2) then the longitude of the fishing area should be determined. The positions and depth of obstructions can then be obtained directly from the listing, including type of damage to gear.

Example: A fisherman plans to fish between lat. 29°00′ and 29°50′N and long. 80°30′ and 80°40′W. He finds the area is in southeastern North America, region 1 (Fig. 1). He then refers to the obstruction location listing for this region. The locations between lat. 29°00′ and 29°50′N are

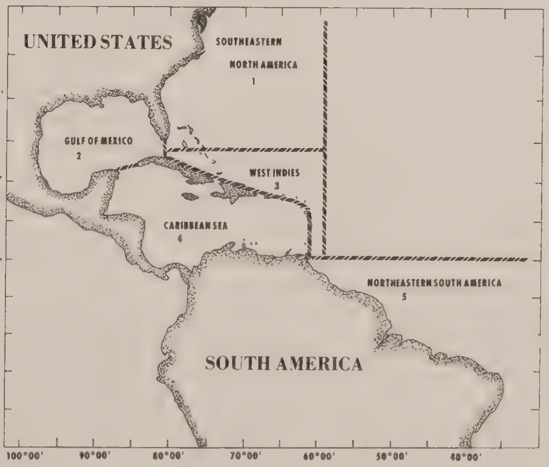

Figure 1.—Geographic boundaries of the five regions where obstructions have been located.

---

[1] ribution No. 77-08P from the Southeast Fisheries Center, Pasca-
aboratory.

[2] ast Fisheries Center Pascagoula Laboratory, National Marine
Service, NOAA, P.O. Drawer 1207, Pascagoula, MS 39567.

blocked off. The obstructions located between long. 80°30′ and 80°40′W can then be easily marked and located on the fishing chart.

It should be kept in mind that an obstruction may deteriorate or be removed after it is reported. Particular attention should be paid to type of gear and damage sustained because other gear may not be affected. Generally loran fixes were used to derive latitude and longitude readings. However, some slight inaccuracies may exist when loran fixes were not provided.

ACKNOWLEDGMENT

We extend our appreciation to Charles M. Roit and Elmer J. Gutherz for reviewing this manusc

LITERATURE CITED

GRAHAM, G. L.
1975. Bottom fishing obstructions. Texas-Louisiana and Texas A&M Univ. Sea Grant Publ. TAMU-SG-76-506.

APPENDIX TABLE

Codes to Gear and Damage

Gear	Abbreviation
Scallop trawl	PT
Lampara seine	LP
Purse seine	PS
Gill net	GN
Lift net	LN
Separator net	SN
Shrimp trawl	ST
Tumbler dredge	TD
Fish trawl	FT
Scallop dredge	SD
Midwater trawl	MT
Beam trawl	BT
Clam dredge	CD

Damage	Abbreviation
Torn webbing	T
Lost whole rig	L
Hang-up	Z
Gear fouled	F

NATIONAL MARINE FISHERIES SERVICE
SEFC,PASCAGOULA LAB

HANG DATA

SOUTHEASTERN NORTH AMERICA
2400 TO 3830 N.LAT. 5930 TO 8100 W.LONG.

ON	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	DAMAGE
	3651	7439	65	3H42286	3H52932	ST	T
	3649	7441	50	3H42257	3H52934	ST	T
	3645	7440	71	3H42220	3H52935	ST	T
	3636	7443	80	3H42112	3H52923	ST	T
	3623	7449	79	3H41940	3H52922	ST	T
	3622	7448	135	3H41936	3H52918	FT	Z
	3554	7452	51	3H41627	3L14817	ST	L
	3550	7454	49	3H41576	3L14814	FT	T
	3549	7453	50	3H41575	3L14810	ST	T
	3546	7450	59	3H41568	3L14799	ST	T
	3545	7448	280	3H51568	3L14794	ST	T
	3544	7451	62	3H41537	3L14799	ST	T
	3542	7451	65	3H41523	3L14793	ST	T
	3541	7452	48	3H41506	3L14794	ST	L
	3536	7451	70	3H41470	3L14782	TD	L
	3522	7452	320	3H41354	3L14755	ST	F
	3517	7500	85	3H41261	3L14758	FT	T
	3515	7459	240	3H41255	3L14753	ST	T
	3508	7508	45	3H41158	3L14754	ST	T
	3507	7504	190	3H41185	3L14745	ST	L
	3506	7509	100	3H41146	3L14752	ST	T
	3506	7510	60	3H41140	3L14753	TD	Z
	3505	7506	200	3H41168	3L14743	ST	T
	3505	7509	120	3H41143	3L14750	ST	T
	3457	7523	50	3L14760	3H61143	ST	T
	3454	7523	101	3H41052	3L14750	ST	T
	3454	7525	75	3L14757	3H61173	ST	T
	3453	7530	38	3L14765	3H61195	FT	T
	3452	7532	38	3L14765	3H61211	FT	T
	3446	7537	50	3L14759	3H61295	ST	T
	3445	7538	40	3L14758	3H61304	ST	T
	3438	7548	34	3L14763	3H61425	FT	Z
	3437	7538	103	3L14740	3H61378	ST	L
	3437	7544	35	3L14754	3H61409	FT	T
	3436	7545	38	3L14753	3H61425	FT	Z
	3433	7546	50	3L14746	3H61459	ST	T
	3433	7706	9	3L14926	3H62086	ST	T
	3432	7651	11	3L14888	3H61970	FT	T
	3431	7640	9	3L14860	3H61880	ST	T
	3426	7542	215	3L14718	3H61498	ST	T
	3425	7652	12	3L14876	3H62019	ST	T
	3424	7544	215	3L14719	3H61523	ST	T
	3418	7708	13	3L14999	3H62205	FT	T

NATIONAL MARINE FISHERIES SERVICE
SEFC,PASCAGOULA LAB

HANG DATA

SOUTHEASTERN NORTH AMERICA
2400 TO 3830 N.LAT. 5930 TO 8100 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DA
1	3416	7554	195	3L14717 3H61653	ST	
1	3416	7726	11	3L14940 3H62375	FT	
1	3414	7637	18	3L14811 3H61975	ST	
1	3407	7719	13	3L14898 3H62374	ST	
1	3407	7722	13	3L14908 3H62401	FT	
1	3404	7615	50	3L14730 3H61896	ST	
1	3357	7721	15	3L14877 3H62467	ST	
1	3354	7808	5	3L15002 3H62981	CD	
1	3352	7813	5	3L15009 3H62935	ST	
1	3343	7623	220	3L14678 3H62114	ST	
1	3341	7720	14	3L14830 3H62571	FT	
1	3340	7721	15	3L14834 3H62575	FT	
1	3339	7633	143	3L14690 3H62220	TD	
1	3336	7657	54	3L14745 3H62420	SD	
1	3335	7814	10	3L14973 3H63065	FT	
1	3333	7641	150	3L14746 3H62319	ST	
1	3329	7822	12	3L14979 3H63174	ST	
1	3325	7640	220	3L14658 3H62368	ST	
1	3324	7818	14	3L14951 3H63175	ST	
1	3324	7820	13	3L14964 3H63198	ST	
1	3321	7740	15	3L14820 3H62875	FT	
1	3321	7832	11	3L14993 3H63312	ST	
1	3320	7740	14	3L12812 3H62877	FT	
1	3305	7711	190	3L14659 3H62740	ST	
1	3301	7849	12	3L14983 3H63595	ST	
1	3255	7808	50	3L14805 3H63270	FT	
1	3254	7727	175	3L14655 3H62927	ST	
1	3254	7812	38	3L14813 3H63304	MT	
1	3253	7833	20	3L14889 3H63500	ST	
1	3250	7817	30	3L14811 3H63374	FT	
1	3249	7838	18	3L14887 3H63565	ST	
1	3248	7820	30	3L14812 3H63414	FT	
1	3247	7823	30	3L14818 3H63445	FT	
1	3239	7833	51	3L14809 3H63570	CD	
1	3239	7836	27	3L14815 3H63587	SD	
1	3237	7951	6	3L15125 3H64260	ST	
1	3235	7829	103	3L14770 3H63546	CD	
1	3234	7921	14	3L14076 3H64014	ST	
1	3232	7844	25	3L14805 3H63690	ST	
1	3228	7849	45	3L14793 3H63744	ST	
1	3227	7806	190	3L14632 3H63381	BT	
1	3220	7812	190	3L14600 3H63459	ST	
1	3219	7945	14	3L14900 3H64196	FT	
1	3219	7946	15	3L14900 3H64200	ST	

NATIONAL MARINE FISHERIES SERVICE
SEFC,PASCAGOULA LAB

HANG DATA

SOUTHEASTERN NORTH AMERICA
2400 TO 3830 N.LAT. 5930 TO 8100 W.LONG.

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
	3216	7905	40	3L14765 3H63903	ST	T
	3210	7834	233	3L14598 3H63669	TD	Z
	3209	8021	8	3L14740 3H64279	ST	F
	3204	8024	9	3L14673 3H64676	ST	F
	3203	7926	30	3L14684 3H64063	FT	Z
	3152	7822	320	3L14400 3H63605	ST	T
	3146	8034	11	3L14442 3H64264	ST	T
	3135	7938	50	3L14375 3H64087	ST	T
	3131	7927	220	3L14308 3H64033	ST	T
	3131	7946	29	3L14316 3H64115	FT	Z
	3111	7955	30	3L14078 3H64120	ST	T
	3110	7954	32	3L14072 3H64115	FT	Z
	3106	7956	29	3L14004 3H64115	ST	T
	3105	7956	30	3L13996 3H64113	ST	L
	3058	7947	175	3L13900 3H64073	ST	T
	3056	8110	9	3L13800 3H64251	FT	F
	3049	8015	23	3L13782 3H64146	ST	T
	3036	8013	24	3L13635 3H64124	TD	F
	3031	8002	150	3L13579 3H64088	ST	T
	3025	8026	23	3L13485 3H64142	ST	T
	3023	8004	182	3L13474 3H64080	ST	Z
	3017	8016	28	3L13395 3H64109	ST	T
	3016	8012	25	3L13385 3H64094	ST	T
	3010	8016	38	3L13308 3H64098	TD	Z
	3008	8018	26	3L13281 3H64100	FT	T
	3001	8010	180	3L13200 3H64074	ST	F
	3001	8031	22	3L13191 3H64124	TD	F
	3000	8008	189	3L13190 3H64068	ST	F
	3000	8010	180	3L13188 3H64073	ST	T
	2959	8009	210	3L13182 3H64068	ST	T
	2958	8010	185	3L13173 3H64070	ST	L
	2958	8011	160	3L13163 3H64071	ST	T
	2957	8011	175	3L13150 3H64070	ST	F
	2955	8010	200	3L13124 3H64063	ST	T
	2955	8012	150	3L13125 3H64069	ST	T
	2954	8011	185	3L13119 3H64068	ST	T
	2954	8013	190	3L13115 3H64073	ST	T
	2953	8005	250	3L13112 3H64050	ST	T
	2953	8012	180	3L13100 3H64071	ST	T
	2953	8013	180	3L13101 3H64072	ST	F
	2953	8019	29	3L13100 3H64087	SD	Z
	2952	8011	180	3L13091 3H64068	ST	F
	2952	8012	180	3L13087 3H64070	ST	F
	2952	8013	180	3L13085 3H64070	ST	T

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REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	D
1	2952	8017	29	3L13090 3H64081	FT	
1	2952	8031	20	3L13085 3H64111	FT	
1	2950	8007	200	3L13070 3H64052	ST	
1	2950	8011	180	3L13073 3H64065	ST	
1	2950	8012	200	3L13075 3H64061	ST	
1	2949	8036	18	3L13045 3H64120	TD	
1	2948	8010	185	3L13045 3H64059	ST	
1	2948	8012	162	3L13044 3H64063	ST	
1	2947	8011	180	3L13025 3H64058	ST	
1	2947	8013	195	3L13027 3H64062	ST	
1	2946	8010	195	3L13011 3H64056	ST	
1	2946	8011	185	3L13006 3H64057	ST	
1	2945	8012	200	3L13000 3H64058	ST	
1	2945	8028	18	3L12996 3H64096	FT	
1	2944	8010	177	3L12993 3H64053	ST	
1	2944	8103	12	3L12978 3H64165	TD	
1	2942	8010	180	3L12971 3H64050	ST	
1	2940	8011	170	3L12941 3H64053	ST	
1	2940	8017	40	3L12943 3H64069	ST	
1	2939	8012	185	3L12925 3H64051	ST	
1	2938	8016	50	3L12915 3H64061	ST	
1	2937	8010	210	3L12900 3H64048	ST	
1	2935	8011	100	3L12875 3H64045	ST	
1	2931	8008	215	3L12835 3H64036	ST	
1	2931	8009	185	3L12838 3H64039	ST	
1	2930	8008	180	3L12820 3H64036	ST	
1	2929	7953	375	3L12812 3H63993	ST	
1	2928	8008	200	3L12797 3H64033	ST	
1	2928	8009	200	3L12796 3H64035	ST	
1	2925	8014	38	3L12760 3H64042	FT	
1	2925	8015	35	3L12755 3H64045	TD	
1	2924	8007	190	3L12751 3H64025	ST	
1	2922	8006	200	3L12724 3H64019	ST	
1	2922	8007	185	3L12723 3H64023	ST	
1	2921	8039	16	3L12705 3H64097	TD	
1	2920	7949	200	3L12700 3H63974	ST	
1	2920	8014	35	3L12690 3H64037	SD	
1	2920	8016	30	3L12698 3H64045	SD	
1	2919	7959	245	3L12687 3H63697	ST	
1	2919	8018	25	3L12686 3H64048	BT	
1	2918	7959	260	3L12675 3H63996	ST	
1	2917	8004	360	3L52294 3H63845	ST	
1	2914	8002	238	3L12625 3H64001	ST	
1	2913	8032	16	3L12607 3H64074	TD	

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LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
2912	8002	203	3L12599 3H64000	ST	T
2912	8019	21	3L12598 3H64043	MT	F
2910	8005	80	3L12575 3H64009	SD	Z
2909	8000	205	3L51348 3H63990	ST	T
2909	8037	13	3L12560 3H64080	TD	F
2907	8001	195	3L12550 3H63998	ST	L
2907	8031	15	3L12543 3H64067	TD	F
2906	8017	25	3L12525 3H64033	TD	F
2905	8016	25	3L12510 3H64035	PT	L
2904	8013	32	3L12499 3H64023	FT	T
2902	8016	26	3L12476 3H64030	TD	F
2902	8038	12	3L12475 3H64076	TD	F
2902	8039	11	3L12477 3H64080	TD	F
2901	8031	13	3L12455 3H64059	TD	Z
2859	7957	222	3L12443 3H63976	ST	F
2858	8007	46	3L12429 3H64000	ST	T
2856	8003	100	3L13141 3H64045	ST	Z
2856	8016	22	3L12400 3H64023	SD	F
2854	8007	45	3L12378 3H63997	BT	T
2854	8036	12	3L12379 3H64065	TD	I
2853	7958	180	3L12370 3H63975	ST	T
2853	8014	20	3L12370 3H64026	SD	T
2852	7946	350	3L12365 3H63945	ST	T
2852	7954	200	3L12360 3H63963	ST	T
2852	8033	14	3L12352 3H64057	TD	F
2850	8004	80	3L12330 3H63988	BT	F
2849	8010	31	3L12317 3H64000	ST	Z
2848	8028	13	3L12300 3H64041	TD	F
2848	8028	13	3L12300 3H64041	TD	F
2843	8005	40	3L12248 3H63986	BT	T
2842	8008	31	3L12228 3H63986	ST	Z
2842	8012	27	3L12227 3H64000	TD	F
2835	8014	17	3L51223 3H63997	SD	F
2834	8007	30	3L51247 3H63981	ST	T
2833	8015	18	3L51212 3H63999	TD	F
2830	7951	182	3L51311 3H63938	ST	Z
2830	7952	200	3L51306 3H63940	ST	L
2827	8004	35	3L51242 3H63969	TD	Z
2826	7951	180	3L51303 3H63935	ST	T
2826	8010	26	3L51213 3H63982	FT	T
2825	8005	32	3L51236 3H63969	ST	T
2824	8014	20	3L51195 3H63990	TD	F
2823	8009	25	3L51212 3H63977	TD	F
2823	8017	15	3L12000 3H63996	SD	T

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2400 TO 3830 N.LAT. 5930 TO 8100 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	D
1	2823	8031	8	3L12000 3H64025	ST	
1	2821	7951	180	3L51294 3H63935	ST	
1	2821	8014	15	3L51189 3H63987	SD	
1	2819	8034	6	3L11968 3H64031	ST	
1	2818	8034	6	3L11950 3H64028	ST	
1	2816	8005	28	3L51212 3H63962	ST	
1	2811	8010	22	3L51180 3H63971	TD	
1	2809	8003	36	3L51205 3H63953	ST	
1	2809	8010	19	3L51175 3H63969	SD	
1	2809	8014	16	3L51160 3H63978	SD	
1	2807	7940	305	3L51325 3H63896	TD	
1	2803	8006	23	3L51178 3H63956	ST	
1	2803	8014	16	3L51144 3H63974	TD	
1	2800	8006	23	3L51170 3H63954	TD	
1	2759	7856	480	3L51635 3H63771	ST	
1	2759	8008	22	3L51159 3H63957	ST	
1	2759	8012	15	3L51141 3H63966	MT	
1	2757	8005	22	3L51168 3H63949	TD	
1	2753	8005	22	3L51157 3H63946	SD	
1	2753	8008	20	3L51143 3H63954	TD	
1	2752	8003	26	3L51164 3H63941	ST	
1	2751	8002	31	3L51164 3H63939	FT	
1	2742	8003	23	3L51137 3H63935	SD	
1	2740	7959	50	3L51151 3H63925	FT	
1	2739	7959	41	3L51149 3H63924	FT	
1	2738	8006	15	3L51111 3H63940	SD	
1	2737	8006	18	3L51109 3H63939	TD	
1	2736	8006	14	3L51105 3H63938	SD	
1	2735	8005	18	3L51108 3H63935	FT	
1	2723	7907	10	3L51660 3H63789	ST	
1	2721	7915	265	3L51490 3H63809	FT	
1	2716	8002	26	3L51069 3H63918	FT	
1	2712	7952	180	3L51142 3H63893	ST	
1	2650	7944	200	3L51220 3H63874	ST	
1	2631	8001	33	3L51309 3H63893	ST	
1	2627	8001	13	3L51345 3H63891	ST	
1	2547	7919	25	3L51960 3H63787	TD	
1	2545	7959	150	3L51697 3H63867	TD	
1	2543	7920	120	3L51985 3H63787	TD	
1	2535	8000	210	3L51771 3H63866	ST	
1	2531	8000	225	3L51802 3H63864	ST	
1	2531	8006	15	3L51769 3H63876	SD	
1	2530	7919	368	3L52071 3H63785	ST	
1	2522	7919	300	3L52151 3H63779	ST	

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ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
	2520	8000	240	3L51887 3H63860	ST	Z
1	2517	8010	25	3L51852 3H63877	ST	T
1	2516	8010	15	3L51859 3H63877	ST	T
	2445	7918	300	3L52406 3H63780	ST	F

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ON	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
2	2431	8116	98	3L33583 3H13532	SD	Z
	2415	8124	153	3L33557 3H13489	TD	F
	2413	8141	250	3L33552 3H13461	ST	T
2	2618	8202	6	3H13667 3H01013	SN	T
2	2600	8203	7	3H01032 3H13627	ST	T
	2545	8203	10	3H01046 3H13596	ST	T
	2617	8203	8	3H01016 3H13662	ST	T
2	2609	8210	9	3H01034 3H13636	ST	T
	2451	8212	14	3H01112 3H13475	ST	T
	2416	8230	200	3H01178 3H13374	ST	T
2	2446	8230	15	3H01160 3H13429	ST	L
2	2648	8245	14	3H01130 3H13668	ST	T
	2418	8254	200	3H01241 3H13326	ST	F
	2450	8259	25	3H01246 3H13376	MT	T
2	2446	8259	25	3H01248 3H13368	ST	T
	2722	8302	13	3H01428 3H13727	ST	T
	2422	8305	40	3H01274 3H13308	ST	L
2	2450	8307	15	3H01271 3H13456	ST	T
2	2504	8308	30	3H01273 3H13382	ST	T
	2717	8310	13	3H01465 3H13702	ST	T
	2707	8319	23	3H01483 3H13657	ST	T
2	2425	8323	215	3H01332 3H13270	ST	T
	2428	8329	220	3H01356 3H13260	ST	T
	2429	8330	210	3H01357 3H13259	ST	T
	2429	8331	220	3H01360 3H13258	ST	T
2	2433	8334	250	3H01372 3H13257	ST	T
	2930	8335	5	3H02744 3H33473	ST	T
	2928	8403	11	3H02948 3H33474	ST	T
2	2845	8407	16	3H02650 3H13877	ST	T
2	2925	8412	13	3H03000 3H33471	ST	T
	2938	8415	11	3H03101 3H33492	ST	T
	2455	8417	215	3H01573 3H33160	ST	L

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2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	DA
2	2517	8425	230	3H01641	3H33190	ST	
2	2946	8432	6	3H03282	3H13991	ST	
2	2759	8510	230	3H02681	3H13505	FT	
2	2914	8515	21	3H03400	3H13859	SD	
2	2909	8517	18	3H03360	3H13799	SD	
2	2804	8527	240	3H02809	3H13439	FT	
2	2747	8527	400	3H02675	3H13370	ST	
2	2808	8546	330	3H02927	3H13340	FT	
2	2807	8552	385	3H02942	3H13296	FT	
2	2932	8604	40	3H03608	3H13524	FT	
2	2836	8615	200	3H03232	3H13236	ST	
2	2854	8626	200	3H03372	3H13198	ST	
2	2907	8637	225	3H03455	3H13124	ST	
2	2240	8637	206	3H01879	3H32569	ST	
2	2915	8639	215	3H03498	3H13123	ST	
2	2930	8640	150	3H03567	3H13136	ST	
2	3000	8645	60	3H03656	3H13102	ST	
2	3004	8645	45	3H03664	3H13101	ST	
2	2848	8647	300	3H03347	3H12976	ST	
2	3003	8648	57	3H03660	3H13072	ST	
2	3004	8655	54	3H03656	3H13000	ST	
2	3006	8656	36	3H03659	3H12989	ST	
2	2950	8703	98	3H03616	3H12910	MT	
2	3019	8707	4	3H03671	3H12875	FT	
2	2911	8709	490	3H02659	3H12855	ST	
2	2306	8711	150	3H02018	3H32578	ST	
2	2845	8714	480	3H03341	3H12706	FT	
2	2915	8717	450	3H03483	3H12723	ST	
2	2939	8719	56	3H03572	3H12729	FT	
2	2922	8724	220	3H03508	3H12655	ST	
2	2958	8726	17	3H03618	3H12674	ST	
2	2939	8727	33	3H03566	3H12647	GN	
2	2921	8727	250	3H03503	3H12622	ST	
2	2928	8728	55	3H03528	3H12620	FT	
2	2926	8729	80	3H03522	3H12608	ST	
2	2933	8730	38	3H03545	3H12607	ST	
2	2358	8730	200	3H02173	3H32675	ST	
2	2924	8731	100	3H03512	3H12581	ST	
2	2929	8731	37	3H03531	3H12587	FT	
2	2921	8732	245	3H03501	3H12571	ST	
2	2914	8735	500	3H03474	3H12526	ST	
2	2935	8735	30	3H03547	3H12553	FT	
2	2926	8735	40	3H03518	3H12546	FT	
2	2920	8740	100	3H03494	3H12480	FT	

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2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	DAMAGE
2939	8740	20	3H03556	3H12507	FT	F
2917	8742	208	3H03482	3H12456	ST	F
2923	8744	50	3H03503	3H12442	ST	L
2912	8746	425	3H03462	3H12427	FT	F
2923	8748	45	3H03502	3H12399	ST	T
2855	8749	900	3H03393	3H12359	ST	T
2915	8750	200	3H03472	3H12370	FT	F
2915	8751	190	3H03471	3H12360	ST	T
2941	8755	22	3H03554	3H12349	FT	T
2938	8755	22	3H03546	3H12347	MT	F
2912	8756	243	3H03459	3H12301	ST	F
2913	8757	225	3H03461	3H12290	FT	T
2925	8759	35	3H03503	3H12277	FT	T
2923	8800	43	3H03496	3H12269	ST	T
2911	8801	225	3H03455	3H12249	ST	T
2912	8802	225	3H03453	3H12239	FT	T
2910	8802	270	3H03451	3H12236	ST	T
2912	8803	225	3H03456	3H12227	ST	T
2912	8805	195	3H12202	3H03457	ST	T
2910	8805	250	3H12204	3H03449	ST	L
2954	8806	17	3H12251	3H03581	MT	F
2929	8806	45	3H12212	3H03513	ST	T
2911	8807	200	3H12181	3H03453	FT	T
3014	8808	4	3H12268	3H03622	LN	T
3013	8808	7	3H12265	3H03620	FT	L
2919	8808	50	3H12170	3H03478	ST	T
2902	8808	500	3H12164	3H03420	FT	F
2900	8808	712	3H12162	3H03412	ST	T
2856	8808	838	3H12162	3H03396	ST	Z
3014	8809	5	3H12255	3H03621	MT	Z
2910	8810	205	3H12150	3H03449	ST	F
2921	8811	46	3H12150	3H03486	ST	T
2911	8811	200	3H12140	3H03452	ST	L
2906	8811	290	3H12135	3H03434	ST	T
3012	8812	7	3H12222	3H03615	MT	F
2912	8812	130	3H12130	3H03454	FT	F
2914	8813	68	3H12120	3H03461	ST	T
2910	8813	200	3H12118	3H03447	FT	F
2912	8814	120	3H12110	3H03455	ST	L
2909	8814	225	3H12105	3H03443	ST	F
2917	8816	46	3H12090	3H03467	FT	T
2915	8816	50	3H12090	3H03465	FT	T
2843	8817	825	3H12064	3H03348	ST	L
2915	8818	50	3H12070	3H03463	ST	F

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2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	D
2	2912	8818	100	3H12065 3H03454	ST	
2	2909	8818	200	3H12063 3H03442	ST	
2	2907	8818	250	3H12065 3H03436	ST	
2	2906	8819	260	3H12050 3H03431	ST	
2	2954	8820	20	3H12109 3H03573	ST	
2	3009	8821	7	3H12126 3H03605	ST	
2	3007	8821	10	3H12125 3H03601	GN	
2	3014	8822	3	3H12130 3H03613	MT	
2	2957	8823	18	3H12080 3H03578	ST	
2	2918	8823	36	3H12015 3H03472	ST	
2	2905	8823	215	3H12007 3H03428	ST	
2	2900	8824	400	3H11995 3H03411	LP	
2	2915	8825	60	3H11995 3H03461	ST	
2	3015	8825	3	3H12102 3H03613	MT	
2	2947	8825	19	3H12040 3H03553	FT	
2	2943	8825	21	3H12030 3H03543	MT	
2	2850	8826	600	3H11972 3H03375	FT	
2	2905	8827	215	3H11965 3H03427	ST	
2	2859	8827	400	3H11963 3H03406	ST	
2	2917	8828	38	3H11967 3H03468	ST	
2	2905	8828	200	3H11951 3H03428	ST	
2	3013	8830	3	3H12050 3H03607	LN	
2	2939	8830	22	3H11975 3H03530	ST	
2	2937	8831	20	3H11959 3H03525	ST	
2	2926	8831	30	3H11940 3H03494	ST	
2	2957	8833	14	3H11982 3H03572	GN	
2	2919	8833	35	3H11910 3H03472	MT	
2	2909	8833	110	3H11904 3H03440	ST	
2	2932	8834	22	3H11916 3H03509	MT	
2	2919	8834	35	3H11900 3H03471	MT	
2	2903	8834	220	3H11890 3H03418	ST	
2	2912	8835	32	3H11885 3H03449	FT	
2	2901	8835	205	3H11875 3H03411	ST	
2	2913	8836	40	3H11874 3H03452	MT	
2	2901	8836	200	3H11870 3H03412	ST	
2	2930	8837	20	3H11880 3H03502	ST	
2	2924	8837	29	3H11875 3H03486	MT	
2	2208	8838	20	3H02132 3H32327	ST	
2	3017	8840	3	3H11970 3H03609	MT	
2	2917	8840	35	3H11833 3H03463	ST	
2	2857	8840	230	3H11825 3H03398	ST	
2	2911	8841	41	3H11830 3H03445	ST	
2	2851	8841	405	3H11820 3H03378	ST	
2	2919	8842	32	3H11818 3H03468	FT	

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HANG DATA

GULF OF MEXICO
2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	DAMAGE
	2906	8843	54	3H11798	3H03428	ST	T
2	2229	8843	28	3H02178	3H32365	MT	T
	2922	8844	27	3H11799	3H03477	ST	Z
	2926	8845	15	3H03488	3H11787	MT	L
2	2912	8845	38	3H11778	3H03448	FT	Z
2	2853	8845	270	3H11775	3H03386	ST	F
	3004	8846	8	3H03581	3H11873	MT	T
	2854	8846	220	3H03389	3H11766	ST	T
2	2232	8847	29	3H02195	3H32369	ST	T
	2928	8848	9	3H03492	3H11765	MT	L
	2916	8848	34	3H03458	3H11747	ST	T
	2910	8849	48	3H03440	3H11730	FT	T
2	2914	8850	38	3H03451	3H11725	SN	T
	2910	8850	40	3H03439	3H11724	ST	L
	2915	8851	32	3H03454	3H11719	FT	T
2	2902	8852	74	3H03414	3H11700	ST	T
2	2913	8852	36	3H03448	3H11702	ST	T
	3002	8854	4	3H03572	3H11790	LN	T
	2921	8857	17	3H03471	3H11660	MT	T
2	2852	8857	160	3H03381	3H11653	FT	F
	2850	8858	185	3H03375	3H11645	ST	F
	2835	8912	180	3H03337	3H11536	ST	L
2	2858	8912	14	3H03400	3H11494	ST	L
2	2843	8918	80	3H03354	3H11467	ST	T
	2849	8933	45	3H21067	3H33458	ST	L
	2846	8934	48	3H21082	3H33449	ST	F
2	2859	8934	30	3H21032	3H33488	ST	L
	2327	8934	124	3H02400	3H32413	ST	T
	2841	8935	58	3H21105	3H33435	ST	T
2	2300	8936	76	3H02348	3H32342	ST	F
2	2851	8937	40	3H21068	3H33465	ST	T
	2843	8939	50	3H21106	3H33443	ST	L
	2844	8942	47	3H21114	3H33445	FT	T
2	2849	8943	30	3H21091	3H33461	ST	T
	2856	8954	20	3H21098	3H33486	FT	T
	2227	8959	37	3H02330	3H32225	ST	T
2	2829	9000	60	3H21270	3H33402	ST	L
2	2832	9004	39	3H21277	3H33412	FT	T
	2819	9006	50	3H21348	3H33368	FT	T
	2834	9010	32	3H21304	3H33420	ST	T
2	2827	9015	30	3H21370	3H33396	ST	T
	2222	9015	30	3H22127	3H32183	FT	T
	2821	9029	30	3H21498	3H33377	ST	T
2	2814	9041	40	3H21619	3H33351	FT	T

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HANG DATA

GULF OF MEXICO
2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	D
2	2811	9051	45	3H21710	3H33340	FT	
2	2815	9055	52	3H21734	3H33356	FT	
2	2834	9059	16	3H21723	3H33433	FT	
2	2753	9105	225	3H21875	3H33261	ST	
2	2806	9106	58	3H21853	3H33318	ST	
2	2815	9111	40	3H21875	3H33355	TD	
2	2810	9113	50	3H21905	3H33335	ST	
2	2213	9114	52	3H22318	3H32029	FT	
2	2806	9119	64	3H21966	3H33317	TD	
2	2217	9129	55	3H22358	3H32007	FT	
2	2833	9131	22	3H22038	3H33437	SN	
2	2815	9135	34	3H22099	3H33356	ST	
2	2822	9135	34	3H22090	3H33387	ST	
2	2832	9138	22	3H22108	3H32435	SN	
2	1948	9142	23	3H22430	3H31756	FT	
2	2739	9145	500	3H22232	3H33177	ST	
2	2818	9146	35	3H22199	3H33372	FT	
2	2736	9146	400	3H22243	3H33161	ST	
2	2825	9146	30	3H22194	3H33404	SN	
2	1951	9147	27	3H22445	3H31747	FT	
2	1956	9147	27	3H22440	3H31752	FT	
2	1942	9149	27	3H22448	3H31732	FT	
2	2812	9151	46	3H22254	3H33341	FT	
2	2002	9151	27	3H22450	3H31744	FT	
2	2005	9151	27	3H22447	3H31753	FT	
2	1945	9151	27	3H22455	3H31735	FT	
2	2001	9152	26	3H22452	3H31748	FT	
2	2003	9152	26	3H22452	3H31750	FT	
2	2003	9153	26	3H22455	3H31748	FT	
2	2023	9153	18	3H22452	3H31770	ST	
2	2818	9154	36	3H22280	3H33372	ST	
2	2002	9154	28	3H22457	3H31745	FT	
2	2900	9155	9	3H22273	3H33562	ST	
2	2003	9155	24	3H22459	3H31744	FT	
2	1949	9157	45	3H22470	3H31725	FT	
2	2002	9157	30	3H22469	3H31739	FT	
2	2811	9158	40	3H22323	3H33336	FT	
2	2004	9158	30	3H22473	3H31748	TR	
2	2003	9200	32	3H22475	3H31732	TR	
2	2837	9201	22	3H22336	3H33466	ST	
2	2810	9209	40	3H22431	3H33330	FT	
2	2742	9217	238	3H22504	3H33170	ST	
2	2811	9220	35	3H22534	3H33335	ST	
2	2811	9227	40	3H22595	3H33332	ST	

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GULF OF MEXICO
2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A		GEAR	DAMAGE
2	1935	9231	100	3H22552	3H31641	ST	L
2	2755	9233	110	3H22650	3H33235	ST	F
2	2810	9235	52	3H22677	3H33326	FT	T
2	2801	9235	50	3H22670	3H33270	TD	L
2	2809	9240	40	3H22725	3H35316	ST	T
2	2830	9241	28	3H22745	3H33441	FT	Z
2	2843	9251	17	3H22861	3H33519	FT	T
2	2753	9300	100	3H22890	3H33200	FT	T
2	2737	9303	200	3H22892	3H33087	ST	L
2	2925	9307	8	3H23050	3H33736	FT	T
2	2735	9313	210	3H22970	3H33056	SN	F
2	2737	9314	170	3H22985	3H33068	FT	T
2	2805	9315	51	3H23040	3H33270	ST	T
2	2825	9322	40	3H23146	3H33411	ST	T
2	2729	9322	315	3H23030	3H32995	ST	F
2	2806	9324	44	3H23124	3H33271	FT	T
2	1842	9327	33	3H22678	3H31498	PT	Z
2	2734	9330	200	3H23101	3H33015	ST	T
2	2733	9335	300	3H23138	3H32995	ST	F
2	2738	9337	200	3H23165	3H33031	ST	T
2	2738	9341	250	3H23195	3H33024	ST	T
2	2758	9343	55	3H23263	3H33182	ST	T
2	1932	9346	600	3H22734	3H31492	PT	Z
2	2820	9352	31	3H23404	3H33357	ST	T
2	2820	9355	30	3H23432	3H33352	ST	T
2	2803	9409	38	3H23480	3H33172	ST	T
2	2810	9417	27	3H23562	3H33221	FT	T
2	1856	9426	395	3H22814	3H31400	ST	Z
2	2803	9433	33	3H23639	3H33102	ST	T
2	2808	9435	31	3H23670	3H33150	FT	Z
2	2809	9436	30	3H23681	3H33151	FT	Z
2	2800	9438	40	3H23653	3H33055	ST	L
2	2757	9438	50	3H23643	3H33022	ST	T
2	2748	9445	200	3H23643	3H32906	ST	L
2	2745	9448	230	3H23664	3H32861	FT	Z
2	2745	9448	230	3H23664	3H32861	FT	Z
2	2828	9450	23	3H23844	3H33300	FT	Z
2	2804	9451	35	3H23736	3H33040	FT	Z
2	2757	9454	50	3H23720	3H32955	ST	T
2	2805	9505	38	3H23803	3H32983	ST	T
2	1846	9511	39	3H22909	3H31323	ST	Z
2	2805	9518	30	3H23849	3H32912	ST	T
2	2749	9521	60	3H23796	3H32730	FT	T
2	2751	9530	43	3H23831	3H32730	FT	F

HANG DATA

GULF OF MEXICO
2415 TO 3020 N.LAT. 8100 TO 9730 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMA
2	2742	9543	70	3H23836 3H32536	ST	
2	2804	9552	22	3H23932 3H32705	ST	
2	2744	9610	42	3H23902 3H32389	ST	
2	2720	9612	113	3H23834 3H32133	ST	
2	2745	9613	40	3H23911 3H32380	FT	
2	2738	9613	45	3H23891 3H32311	FT	
2	2710	9617	175	3H23816 3H32002	ST	
2	2720	9620	85	3H23851 3H32080	ST	
2	2732	9621	55	3H23887 3H32200	ST	
2	2610	9622	55	3H23663 3H31428	ST	
2	2632	9628	56	3H23726 3H31560	ST	
2	2627	9630	40	3H23725 3H31495	ST	
2	2030	9630	205	3H23150 3H31199	ST	
2	2750	9633	20	3H23956 3H32318	FT	
2	2649	9638	51	3H23801 3H31655	ST	
2	2628	9642	25	3H23755 3H31414	FT	
2	2730	9645	29	3H23921 3H32048	FT	
2	2131	9646	700	3H23246 3H31169	ST	
2	2133	9648	600	3H23249 3H31167	ST	
2	2621	9658	19	3H23770 3H31243	ST	
2	2602	9706	10	3H23741 3H03149	FT	
2	2315	9716	370	3H23446 3H31090	ST	
2	2410	9727	25	3H23557 3H31047	FT	
2	2255	9736	23	3H23458 3H31068	ST	

WEST INDIES
APPROX.1000 TO 2400 N.LAT. 5930 TO 8100 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMA
3	1302	5934	137		ST	
3	1304	5941	130		TD	
3	1305	5943	290		ST	
3	1028	6004	355		ST	
3	1103	6050	37		ST	
3	1353	6050	215		ST	
3	1111	6054	36		ST	
3	1112	6054	41		ST	
3	1109	6054	34		ST	
3	1339	6055	155		TD	
3	2002	6854	30		TD	
3	2000	6856	14		TD	
3	2015	6943	13		TD	

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WEST INDIES
APPROX.1000 TO 2400 N.LAT. 5930 TO 8100 W.LONG.

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
3	2048	7131	355		ST	L
3	2052	7320	180		ST	T
3	2057	7341	17		ST	L
3	2044	7343	500		ST	F
3	2336	7525		3L33543 3L54820		
3	2351	7659	750		TD	F
3	2411	7713	150		TD	Z
3	2330	7933	5		ST	T
3	2325	7940	250		ST	L
3	2400	8027	12		ST	T

CARIBBEAN SEA
APPROX 1000 TO 2200 N.LAT. 6100 TO 8900 W.LONG

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
4	1404	6102	36		TD	Z
4	1536	6109	364		ST	Z
4	1536	6113	332		ST	Z
4	1522	6126	110		TD	Z
4	1534	6129	48		TD	Z
4	1535	6130	160		TD	Z
4	1210	6144	98		TD	Z
4	1212	6145	100		TD	L
4	1206	6145	12		TD	Z
4	1207	6145	40		TD	Z
4	1201	6154	230		ST	Z
4	1104	6205	59		TD	Z
4	1127	6217	68		ST	T
4	1133	6230	200		ST	T
4	1708	6238	18		ST	T
4	1704	6239	143		ST	Z
4	1707	6239	55		TD	Z
4	1716	6244	40		TD	Z
4	1733	6246	365		ST	L
4	1144	6247	390		ST	L
4	1104	6248	25		ST	T
4	1720	6252	305		ST	T
4	1737	6300	360		ST	L
4	1338	6301	392		ST	F
4	1134	6302	175		ST	L
4	1140	6305	245		ST	T
4	1810	6313	31		TD	Z

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CARIBBEAN SEA
APPROX 1000 TO 2200 N.LAT. 6100 TO 8900 W.LONG

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR
4	1807	6320	360		ST
4	1828	6322	363		ST
4	1737	6328	228		ST
4	1529	6337	6		TD
4	1530	6338	200		ST
4	1807	6338	360		ST
4	1740	6346	405		ST
4	1114	6413	30		ST
4	1846	6441	26		ST
4	1836	6446	28		ST
4	1836	6447	25		ST
4	1836	6448	28		ST
4	1838	6457	220		ST
4	1815	6458	23		ST
4	1807	6519	205		ST
4	1039	6520	700		ST
4	1044	6527	700		ST
4	1827	6535	40		ST
4	1026	6543	50		ST
4	1830	6555	150		ST
4	1751	6609	20		ST
4	1832	6647	200		ST
4	1051	6658	53		TD
4	1054	6700	175		ST
4	1056	6702	230		ST
4	1826	6714	250		ST
4	1817	6717	250		ST
4	1806	6724	13		ST
4	1046	6803	40		TD
4	1120	6816	240		ST
4	1958	6854	12	3L23155 3L31015	TD
4	1153	6928	190		ST
4	1235	6956	280		ST
4	1229	7004	108		FT
4	1227	7006	40		FT
4	1150	7040	32		ST
4	1139	7124	15		ST
4	1231	7158	205		ST
4	1202	7228	33		ST
4	1200	7230	20		FT
4	1221	7231	210		ST
4	1219	7234	195		FT
4	1124	7332	35		ST
4	1104	7423	10		ST

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CARIBBEAN SEA
APPROX 1000 TO 2200 N.LAT. 6100 TO 8900 W.LONG

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
	1105	7428	13		ST	T
	1109	7428	200		ST	F
	1119	7453	580		ST	T
	1112	7456	235		ST	L
	1114	7521	720		ST	T
	1107	7530	600		ST	T
	1005	7553	50		TD	Z
	0959	7553	60		ST	T
	0951	7557	45		ST	F
	1004	7606	110		TD	Z
	0912	7621	24		ST	T
	0936	7622	280		ST	T
	0958	7629	695		ST	Z
	0932	7638	800		ST	Z
	0855	7656	360		FT	T
	1736	7705	16		ST	T
	1826	7706	200		TD	Z
	0938	7857	65		TD	Z
	0819	7948	20		ST	T
	0825	7956	5		ST	T
	0826	7956	8		ST	T
	0827	7956	8		ST	T
	1416	8026	50		TD	Z
	1414	8029	195		TD	Z
	1530	8104	16		ST	T
	1454	8110	280		SD	Z
	1515	8115	110		ST	T
	1434	8131	240		FT	T
	1650	8133	170		ST	L
	1707	8138	400		ST	L
	1412	8142	400		ST	F
	1643	8153	140		FT	F
	1322	8204	300		ST	Z
	1241	8219	74		FT	Z
	1302	8220	80		FT	L
	1236	8221	76		ST	Z
	1250	8222	66		ST	T
	1219	8222	320		ST	T
	1246	8223	70		FT	Z
	1233	8228	85		FT	U
	1217	8249	20		ST	T
	1134	8307	125		ST	T
	1623	8320	55		ST	T
	1622	8331	167		ST	L

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CARIBBEAN SEA
APPROX 1000 TO 2200 N.LAT. 6100 TO 8900 W.LONG

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMA
4	1626	8331	510		ST	
4	1616	8359	350		ST	T
4	1612	8414	350		ST	
4	1612	8424	325		ST	

NE COAST OF SOUTH AMERICA
0015 TO 1000 N.LAT. 3500 TO 6100 W.LONG.

REGION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAM
5	0945	6047	21		ST	
5	0942	5953	120		ST	T
5	0940	5940	200		ST	
5	0928	6004	44		ST	
5	0924	5941	110		ST	T
5	0917	5919	250		ST	
5	0916	5915	275		ST	
5	0903	5900	75		ST	
5	0806	5741	202		FT	T
5	0751	5442	450		ST	
5	0748	5328	500		ST	
5	0744	5652	200		ST	T
5	0741	5348	370		ST	T
5	0738	5411	75		ST	
5	0732	5412	100		ST	
5	0728	5435	118		ST	T
5	0728	5443	93		ST	
5	0728	5511	75		TD	
5	0727	5347	123		ST	T
5	0725	5435	78		ST	T
5	0718	5707	31		ST	
5	0712	5647	27		ST	
5	0709	5247	380		ST	Z
5	0702	5623	35		ST	
5	0655	5401	31		ST	
5	0651	5341	32		ST	
5	0650	5534	28		ST	T
5	0648	5512	25		ST	
5	0637	5503	22		ST	
5	0637	5558	20		ST	L
5	0631	5347	24		ST	
5	0624	5445	17		ST	
5	0624	5500	16		FT	

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NE COAST OF SOUTH AMERICA
0015 TO 1000 N.LAT. 3500 TO 6100 W.LONG.

ION	LATITUDE	LONGITUDE	DEPTH(FMS)	LORAN A	GEAR	DAMAGE
	0623	5605	17		FT	T
5	0614	5231	38		ST	F
	0610	5238	35		ST	F
	0608	5237	30		ST	Z
5	0556	5203	39		ST	T
5	0556	5220	31		ST	T
	0546	5202	38		ST	T
	0543	5115	100		ST	F
5	0541	5206	35		ST	T
	0538	5252	22		ST	T
	0420	5037	38		ST	T
	0311	3840	25		ST	T
5	0307	3841	140		TD	L
	0304	3858	30		ST	T
	0241	4748	180		ST	T
5	0239	3908	60		ST	L
	0232	4917	11		ST	F
	0231	4051	15		ST	T
	0230	4750	65		ST	T
5	0228	3928	24		ST	T
	0217	3937	30		ST	T
	0150	4731	45		ST	T
5	0145	4646	275		ST	T
	0137	4645	64		ST	T
	0023	4705	21		ST	T
	0017	4427	60		ST	T

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NOAA Technical Report NMFS SSRF-716

Fishes and Associated Environmental Data Collected in New York Bight, June 1974-June 1975

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September 1977

U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
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shes and Associated Environmental Data Collected in New York Bight, June 1974-June 1975

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ABSTRACT

Tabulations of fishes and associated environmental observations are given for 700 trawl stations made during 30 collecting intervals in the New York Bight from June 1974 to June 1975. Summary tables included give the following information: collecting interval data (vessel, dates, stations sampled, gear, and area); station data (date, location, time of day, total catch, and environmental observations); and catch data for 127 species, representing 67 families (location, number, and weight).

The 10 most frequently collected species were: *Merluccius bilinearis* (456 stations), *Scophthalmus aquosus* (419), *Raja erinacea* (411), *Urophycis chuss* (409), *Pseudopleuronectes americanus* (363), *Hippoglossina oblonga* (325), *Lophius americanus* (305), *Peprilus triacanthus* (284), *Paralichthys dentatus* (272), and *Squalus acanthias* (224).

INTRODUCTION

Sandy Hook Laboratory of the National Marine
s Service began a systematic survey during June
benthic fishes occurring in the New York Bight
idy Hook, Lower, and Raritan Bays. This study
igned to provide a comprehensive data base for
and anticipated research needs. This paper con-
pulations of stations, catches, and environmen-
collected during this 13-mo study.

data, when compared with similar time series,
mately contribute a significant portion of the
needed to detect and understand natural and
luced changes in relative abundance, dis-
n, movements, conditions, and reproductive
fishes occurring in the New York Bight.

STUDY AREAS

ew York Bight is that portion of the Atlantic
tal shelf between eastern Long Island, N.Y., and
ay, N.J. (Fig. 1). This study was conducted in
hern section of the New York Bight where the
and and New Jersey coastlines are nearly per-
ar.

udy areas, ocean and bay, were designated to
sampling and data handling. The ocean study
delineated by two sets of imaginary lines and
nd 366-m isobaths (Fig. 2). The first set of lines
seaward from points on Long Island and New
the 28-m isobath; the second set from the 28-m
o the edge of the continental shelf (366 m). The
ly area included Sandy Hook, Lower, and
Bays (Fig. 3).

STATION SELECTION

Station locations in the ocean survey area were selected by a stratified random sampling design (Steel and Torrie 1960). Strata boundaries were determined by depth, i.e., 0-10, 11-19, 20-28, 29-55, 56-110, 111-183, and 184-366 m (Fig. 2). A minimum of two stations per stratum were randomly selected to be sampled during each cruise. Inshore strata (0-28 m) were sampled at a rate of approximately one station per 515 km^2 and offshore strata (29-366 m) at a rate of approximately one station per 1,030 km^2. Grosslein (1969) described additional details pertaining to this sampling method and design.

The bay survey area was divided into 103 sampling blocks. Except where interrupted by land, each block measured 1′ of latitude by 1′ of longitude, i.e., 1.8 km × 1.4 km (2.5 km^2). Trawl stations for all bay cruises were selected randomly from these blocks at the beginning of the study and were retained as permanent stations throughout the study.

MATERIALS AND METHODS

Research vessels used during this study were the 10.4-m *Xiphias* and 19.8-m *Rorqual* from the Northeast Fisheries Center, the 47.2-m *Delaware II* and 57.0-m *Albatross IV* from the National Ocean Survey, and the chartered 27.4-m *Atlantic Twin*. *Xiphias* and *Rorqual* were used exclusively in the bay areas, *Delaware II* was used in both the ocean and the bay, and *Albatross IV* and *Atlantic Twin* were used only in the ocean.

Loran A navigation was the principal method used for positioning on ocean stations. Radar, land ranges, and visual sightings of buoys were used to position vessels on bay stations and some of the inshore ocean stations.

Temperature, salinity, and depth observations were made at each station. Vertical temperature profiles were

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t Fisheries Center Sandy Hook Laboratory, National Marine
rvice, NOAA, Highlands, NJ 07732.

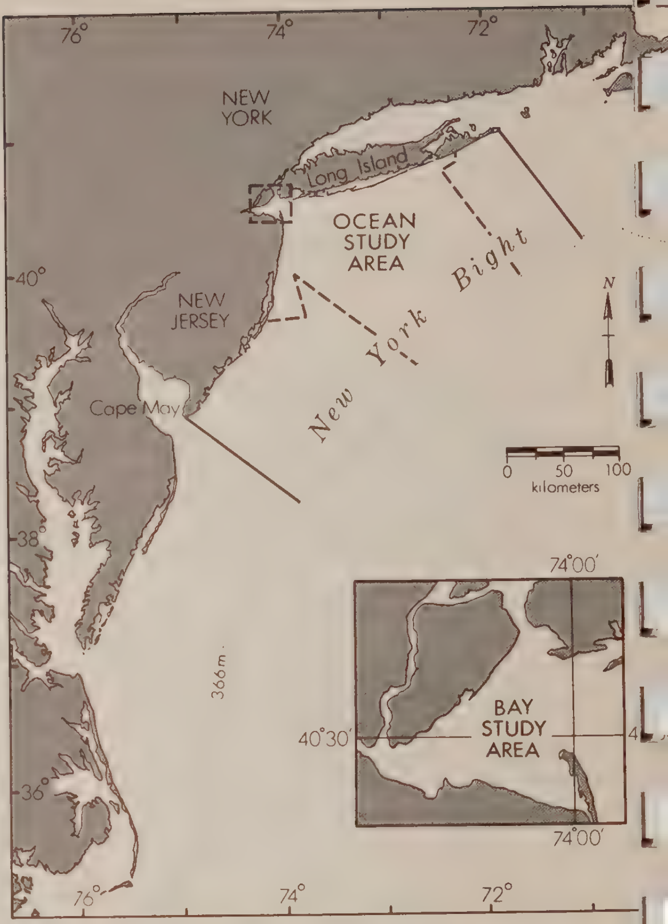
76°
74°
72°
NEW YORK
Long Island
OCEAN STUDY AREA
New York Bight
40°
NEW JERSEY
Cape May
38°
36°
366m
N
0
50
100
kilometers
74°00′
BAY STUDY AREA
40°30′
74°00′
76°
74°
72°

Figure 1.—Middle Atlantic continental shelf with outlines of the New York Bight (solid lines) and the survey areas (dashed lines) within the Bight.

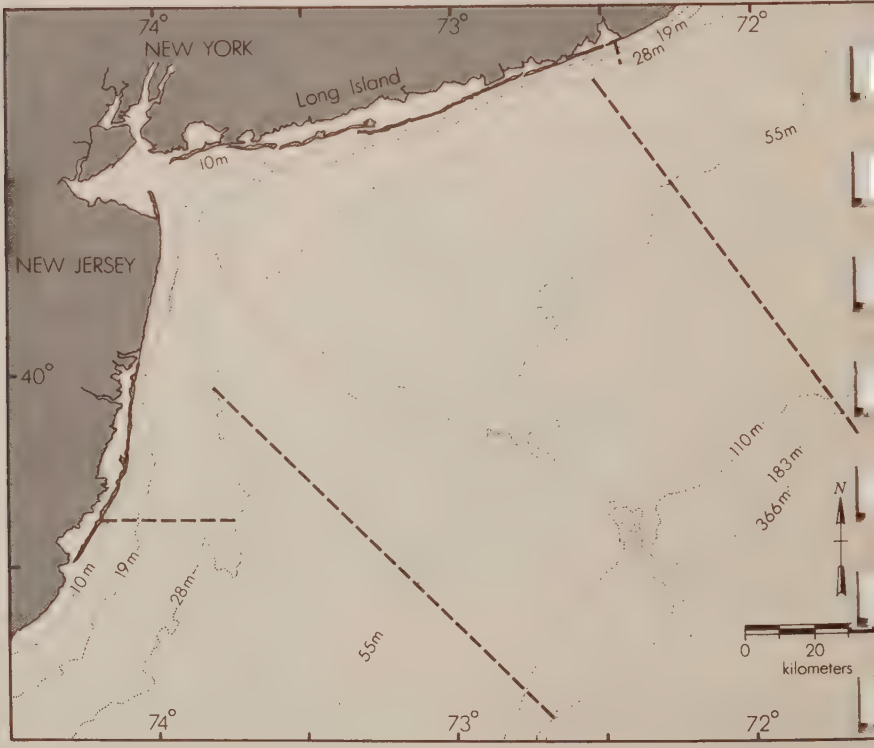
74°
73°
72°
NEW YORK
Long Island
19m
28m
10m
55m
NEW JERSEY
40°
110m
183m
366m
N
10m
19m
28m
55m
0
20
kilometers
74°
73°
72°

Figure 2.—Ocean study area divided into depth strata where finfishes were sampled during an otter trawl survey, June 1974 to June 1975.

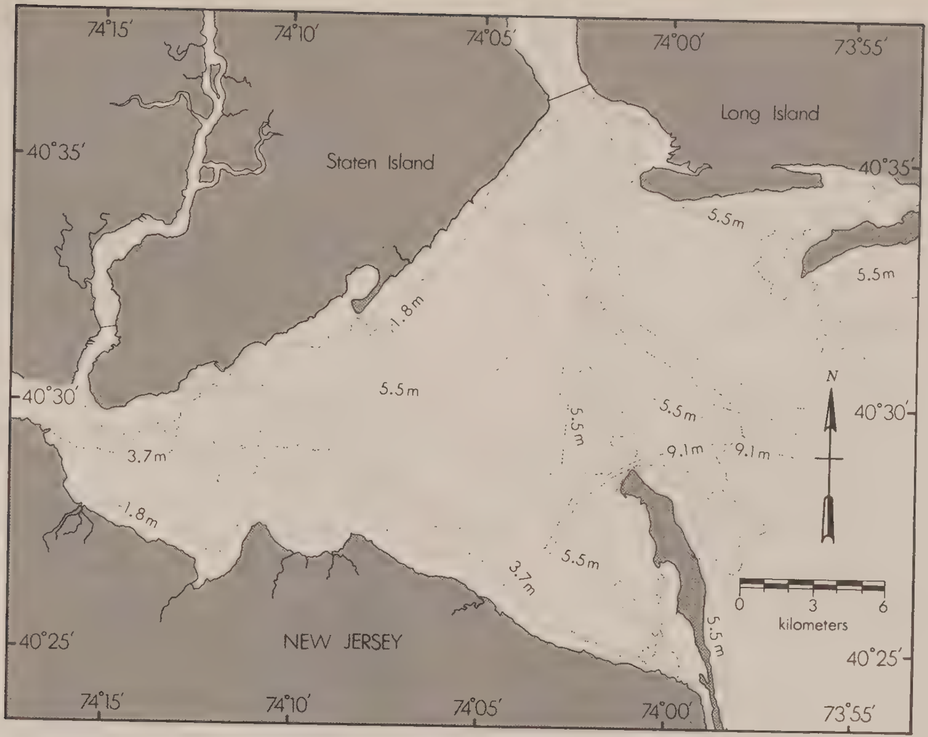

Figure 3.—Bay study area where finfishes were sampled during an otter trawl survey, June 1974 to June 1975.

d with expendable bathythermographs during ruises and with a portable temperature probe bay cruises. Surface water temperature was d at each station with a stem thermometer ac- ±0.1°C for calibration of the expendable bathy- raph and the probe. Surface and bottom water were taken at almost all stations for salinity nation by induction salinometer. Fathometers depth during each trawl tow.

ollections were made with otter trawls towed at nately 6.5 km/h for 15 min at bay stations and 30 ocean stations. The trawl used aboard *Xiphias ual* had a 9.1-m footrope, a 7.6-m headrope, and gs. a Yankee #36 trawl with a 24.4-m footrope, an eadrope, and 9.1-m legs was used on *Delaware lbatross IV* also used the #36 Yankee trawl as #41 trawl with a 30.5-m footrope, a 24.4-m head- d 19.8-m top and 18.3-m bottom legs. The *At- vin* used a ¾ Yankee trawl with a 16.5-m foot- 11.9-m headrope, 11.6-m legs, and 16.5-m ables. All trawls were fitted with 12.7-mm esh cod end liners.

conclusion of each tow, the trawl was retrieved tied onto a sorting table where all fish species arated and identified. All specimens of each ere weighed to the nearest whole pound and from the snout to the middle caudal ray in cen- All specimens of each species were usually except when subsamples of very large catches asured. In such cases, an expansion factor (weight of total catch/weight of subsample) was applied to the number and length frequency of the subsample to estimate the number and length frequency of the total catch.

Samples of each bony fish species, up to 35 specimens, were frozen from each trawl station for subsequent laboratory study. If the total catch of a species exceeded 35 specimens, a size-stratified sample of 25 to 35 specimens was frozen.

Sources of identification and nomenclature used were: Jordan and Evermann (1896-1900), Hildebrand and Schroeder (1928), Ginsburg (1937, 1950, 1951, 1952, 1953, 1954), Hildebrand (1943), Breder (1948), Bigelow and Schroeder (1953), Berry and Anderson (1961), Casey (1964), Eschmeyer (1965), Anderson et al. (1966), Greenwood et al. (1966), Leim and Scott (1966), Gutherz (1967), Böhlke and Chaplin (1968), Randall (1968), Bailey et al. (1970), Rosenblatt and McCosker (1970), and Marshall and Iwamoto (1973).

DATA TABULATIONS

During this study, 700 trawl stations were occupied in 13 mo. Stations were consecutively numbered to aid in cross-referencing location, catch, and associated environmental data. Table 1 lists station numbers, vessel, dates, number of stations, gear type, and study area for each collecting interval. Table 2 provides station information including date, coordinates to the nearest 0.2 km, time of day (EST), trawling duration, number of species and individuals caught, total weight, depth, and surface and bottom temperature and salinity. Table 3 is a phylogenetic list of the 127 species and 67 families of fishes collected during this study including number and weight (kilograms) by station of occurrence. Unless indicated in Table 3, scientific and common names and arrangements are according to Bailey et al. (1970).

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able 1.--Summary of collecting intervals sampled during trawl survey of New York Bight, June 1974 to June 1975.

cutive No.	Vessel	Date	No. of Sta.	Gear Type	Study Area
		1974			
15	*Xiphias*	June 3,4,6	15	9.1-m trawl	bay
18	*Delaware II*	June 3	3	# 36 trawl	bay
61	*Delaware II*	June 3-17	43	# 36 trawl	ocean
76	*Xiphias*	July 23-25	15	9.1-m trawl	bay
79	*Delaware II*	July 24	3	# 36 trawl	bay
120	*Delaware II*	July 24-29	41	# 36 trawl	ocean
136	*Rorqual*	Aug. 14,15,21-23	16	9.1-m trawl	bay
181	*Delaware II*	Aug. 16-21	45	# 36 trawl	ocean
193	*Xiphias*	Sept. 23-25	12	9.1-m trawl	bay
196	*Delaware II*	Sept. 23	3	# 36 trawl	bay
236	*Delaware II*	Sept. 23-28	40	# 36 trawl	ocean
255	*Xiphias*	Oct. 22-24	19	9.1-m trawl	bay
258	*Delaware II*	Oct. 22	3	# 36 trawl	bay
298	*Delaware II*	Oct. 22-28	40	# 36 trawl	ocean
317	*Xiphias*	Nov. 18-20	19	9.1-m trawl	bay
320	*Delaware II*	Nov. 18	3	# 36 trawl	bay
357	*Delaware II*	Nov. 18-25	37	# 36 trawl	ocean
		1975			
371	*Rorqual*	Jan. 3,6,9	14	9.1-m trawl	bay
385	*Rorqual*	Jan. 31; Feb. 3,4	14	9.1-m trawl	bay
388	*Delaware II*	Jan. 31	3	# 36 trawl	bay
439	*Delaware II*	Jan. 31; Feb. 1-6	51	# 36 trawl	ocean
458	*Albatross IV*	Mar. 6-8,10	19	# 41 trawl	ocean
485	*Atlantic Twin*	Mar. 20-24	27	3/4 Yankee trawl	ocean
500	*Rorqual*	Apr. 1,2,7	15	9.1-m trawl	bay
548	*Albatross IV*	Apr. 1-3,5-10	48	# 36 trawl	ocean
564	*Xiphias*	May 5-6,8	16	9.1-m trawl	bay
567	*Delaware II*	May 5	3	# 36 trawl	bay
627	*Delaware II*	May 5-12	60	# 36 trawl	ocean
636	*Xiphias*	June 3,9	9	9.1-m trawl	bay
700	*Delaware II*	June 2-9	64	# 36 trawl	ocean
			700		

Table 2.--Summary of trawl stations made in New York Bight, June 1974 to June 1975. An asterisk (*) indicates a weight less than 0.5 kg and two asterisks (**) indicates data not taken.

Sta. No.	Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity
		Lat. (N)	Long. (W)			No.	Wt. (kg)			Surface	Bottom	Surface
	1974 June											
1	3	40°29.0'	74°03.0'	0958	15	5	4.5	4	8	16.4	15.4	22.8
2	3	40°28.8'	74°04.4'	1130	15	48	1.8	3	7	16.6	15.7	22.3
3	3	40°29.0'	74°05.8'	1310	15	9	0.5	3	7	18.6	15.2	21.8
4	3	40°27.8'	74°08.8'	1427	15	3	0.5	1	4	17.3	17.0	21.0
5	4	40°28.5'	74°12.7'	0830	15	NO FISH CAUGHT			5	17.8	16.9	20.9
6	4	40°30.4'	74°10.2'	0913	15	1	*	1	6	17.8	16.7	22.5
7	4	40°30.6'	74°05.8'	0955	15	2	1.4	2	6	17.6	16.0	22.2
8	4	40°27.8'	74°05.4'	1046	15	2	*	1	5	18.4	16.4	21.9
9	4	40°26.5'	74°02.5'	1137	15	22	2.7	7	5	18.2	16.0	22.4
10	4	40°27.5'	74°01.4'	1227	15	27	3.2	3	6	17.7	15.8	22.6
11	6	40°29.2'	74°01.4'	0809	15	2	*	2	6	16.5	16.4	26.1
12	6	40°30.0'	74°01.3'	0855	15	1	*	1	6	16.5	15.9	25.1
13	6	40°32.8'	74°05.3'	1040	15	NO FISH CAUGHT			5	17.0	16.5	22.4
14	6	40°33.0'	74°03.5'	1215	15	22	3.6	5	12	19.2	16.0	23.0
15	6	40°36.4'	74°02.7'	1335	15	NO FISH CAUGHT			33	18.0	16.2	20.1
16	3	40°29.0'	74°03.0'	0957	15	494	27.2	13	8	16.4	15.4	22.8
17	3	40°28.8'	74°04.4'	1130	15	2859	106.6	18	7	16.6	15.7	22.3
18	3	40°29.0'	74°05.8'	1315	15	2250	22.7	8	8	18.6	15.2	21.8
19	3	40°32.5'	73°41.5'	2224	30	806	93.9	16	15	15.4	14.1	30.9
20	4	40°30.0'	73°40.0'	0017	30	520	51.7	11	18	15.3	13.0	31.0
21	4	40°31.5'	73°36.5'	0152	30	476	73.4	18	19	15.5	13.9	31.0
22	4	40°22.0'	73°29.0'	0340	30	36	18.1	10	26	14.0	10.2	31.0
23	4	40°32.0'	73°27.0'	0525	30	88	45.8	11	15	13.6	13.1	30.9
24	4	40°33.5'	73°21.0'	0644	30	153	56.7	7	20	13.8	13.2	30.7
25	4	40°31.5'	73°17.0'	0815	30	34	40.8	4	26	14.0	10.5	30.8
26	4	40°22.5'	72°59.5'	1023	30	2	0.5	1	38	15.3	7.2	31.7
27	4	40°34.0'	73°03.0'	1203	30	68	31.8	8	24	13.5	11.2	31.0
28	4	40°39.3'	73°01.0'	1324	30	469	50.3	16	14	14.6	11.9	30.6
29	4	40°43.0'	72°49.5'	1501	30	953	42.2	14	16	15.2	12.3	30.7
30	4	40°43.5'	72°43.0'	1630	30	158	37.2	8	26	14.3	11.0	30.8
31	4	40°29.0'	72°22.0'	1905	30	31	20.0	10	53	14.3	6.9	32.4
32	4	40°05.0'	72°12.0'	2148	30	37	10.4	6	74	13.1	6.5	32.5
33	5	30°50.5'	71°56.5'	0017	30	90	2.7	6	134	14.5	12.8	33.7
34	5	39°46.0'	72°15.0'	0227	30	52	5.0	8	97	12.8	11.6	32.6
35	5	39°30.5'	72°10.5'	0450	30	5	*	4	242	13.0	12.0	33.4
36	5	39°30.5'	72°12.0'	0620	30	182	6.4	13	223	13.0	11.8	**
37	5	39°31.5'	72°32.5'	0835	30	28	5.4	7	99	19.2	16.4	33.6
38	5	39°23.0'	72°20.0'	1025	30	800	108.4	4	145	19.0	17.2	35.4
39	5	39°12.0'	72°28.5'	1258	30	124	17.7	10	322	22.5	8.9	35.0
40	5	39°20.0'	72°37.0'	1506	30	8	6.4	3	119	14.8	13.6	35.5
41	5	39°41.0'	72°59.5'	1807	30	12	3.6	5	55	16.7	7.8	33.5
42	5	39°44.0'	73°16.0'	1947	30	36	7.7	8	40	16.4	8.0	31.7
43	5	39°50.5'	73°35.0'	2145	30	61	10.0	10	33	13.2	4.7	30.2
44	5	39°43.0'	73°54.5'	2359	30	129	28.1	10	23	17.1	9.0	30.8
45	6	39°51.0'	73°58.0'	0124	30	184	36,3	11	17	17.1	11.9	29.8
46	6	39°56.0'	74°03.2'	0245	30	1004	88.5	12	16	15.4	12.8	29.9
47	6	39°58.5'	73°57.0'	0424	30	40	38.6	10	17	15.5	11.1	30.9
48	6	40°06.0'	74°01.0'	0544	30	361	56.7	10	15	14.7	11.8	30.2
49	6	40°12.0'	73°49.0'	0720	30	31	17.7	7	27	16.0	8.7	30.2
50	6	40°13.0'	73°54.0'	0816	30	385	71.2	12	22	16.3	11.8	30.9
51	6	40°18.0'	73°50.0'	0923	30	29	26.8	9	27	16.6	7.9	30.5
52	6	40°24.0'	73°54.3'	1130	30	189	86.6	9	17	18.3	12.3	30.4
53	6	40°27.0'	73°51.5'	1322	30	473	89.8	17	19	18.4	11.5	28.5
54	6	40°24.5'	73°47.5'	1513	30	53	29.9	10	35	16.5	7.3	28.8
55	6	40°16.0'	73°44.0'	1915	30	42	10.0	8	30	16.6	8.0	32.2
56	6	40°13.0'	73°37.0'	2035	30	34	20.4	8	35	16.7	7.8	32.1
57	6	40°12.0'	73°31.0'	2150	30	73	33.1	12	38	15.8	7.4	31.1
58	6	40°15.0'	73°35.0'	2356	30	95	12.7	12	27	16.4	9.0	31.1
59	7	40°20.3'	73°45.8'	0150	30	56	26.8	10	28	16.2	7.8	**
60	7	40°24.0'	73°44.5'	0317	30	49	17.7	8	24	15.6	8.7	30.6
61	7	40°32.3'	73°48.5'	0503	30	887	31.3	10	10	15.6	**	30.2

.--Continued

ate	Location		Start	Duration	Total Catch		No. spp.	Depth	Temp. (°C)		Salinity (o/oo)	
	Lat. (N)	Long. (W)	Time	(min)	No.	Wt. (kg)	Caught	(m)	Surface	Bottom	Surface	Bottom
July												
23	40°26.9'	74°05.0'	0845	15	18	1.4	4	6	21.9	22.0	26.9	26.4
23	40°27.0'	74°02.8'	0930	15	86	9.1	6	8	21.0	22.0	27.1	27.0
23	40°27.0'	74°02.0'	1025	15	3	1.4	2	7	21.0	22.0	27.2	27.5
24	40°29.5'	74°03.0'	0828	15	16	8.2	3	9	20.5	22.0	26.9	27.4
24	40°29.0'	74°02.0'	0923	15	13	22.7	4	8	20.7	21.0	27.1	27.1
24	40°26.9'	74°06.0'	1017	15	21	11.3	5	9	21.0	20.5	26.4	27.3
24	40°29.2'	74°06.3'	1056	15	26	11.3	9	10	21.0	20.7	26.8	26.9
24	40°25.3'	74°00.3'	1339	15	11	5.0	4	7	21.5	21.0	26.8	27.8
24	40°28.0'	74°03.2'	1419	15	46	14.5	7	7	20.9	21.0	27.7	27.4
25	40°33.7'	74°03.1'	0948	15	10	2.7	7	11	20.3	19.0	28.3	28.6
25	40°32.9'	74°05.6'	1021	15	1	*	1	6	20.0	19.8	27.0	27.2
25	40°31.0'	74°01.0'	1110	15	3	*	2	6	19.8	19.3	27.9	29.0
25	40°30.8'	74°05.0'	1147	15	2	*	2	7	20.0	20.2	26.7	27.1
25	40°30.6'	74°09.0'	1230	15	7	*	1	6	20.9	21.0	26.5	26.8
25	40°28.0'	74°10.0'	1310	15	2	3.6	2	4	21.0	20.9	26.0	26.1
24	40°27.0'	74°05.0'	0829	15	55	93.9	10	8	21.9	22.0	26.9	27.4
24	40°26.9'	74°03.0'	1015	15	205	44.0	7	7	21.0	22.0	26.4	27.3
24	40°29.2'	74°06.2'	1157	15	876	29.0	9	9	21.0	22.0	26.8	26.9
24	40°30.0'	73°43.0'	1338	30	409	76.2	10	18	19.2	13.5	30.2	32.5
24	40°31.5'	73°32.9'	1510	30	518	26.8	9	15	19.6	**	30.4	31.2
24	40°24.0'	73°31.0'	1646	30	555	52.6	9	22	20.4	13.8	30.9	32.3
24	40°26.6'	73°25.3'	1812	30	125	45.8	9	24	19.9	13.5	30.4	32.5
24	40°31.5'	73°28.0'	1940	30	225	97.1	13	16	19.5	15.1	30.3	32.4
24	40°34.0'	73°18.0'	2125	30	171	70.3	14	18	20.1	15.9	31.3	32.6
24	40°26.5'	73°16.5'	2359	30	514	148.8	10	27	20.3	14.1	31.2	32.8
25	40°23.8'	72°52.4'	0406	30	387	112.9	12	39	20.1	12.9	31.4	31.5
25	40°36.1'	73°01.4'	0706	30	111	5.9	4	20	19.9	10.9	32.0	32.4
25	40°39.0'	72°51.5'	1108	30	70	10.0	5	25	20.4	14.9	32.7	31.8
25	40°44.0'	72°47.8'	1231	30	5244	59.9	16	15	20.4	20.4	31.0	31.8
25	40°44.5'	72°40.0'	1421	30	1382	23.1	6	21	20.1	14.1	31.7	32.3
25	40°48.1'	72°33.2'	1546	30	18002	109.8	15	17	18.9	17.9	31.6	31.8
26	40°35.4'	72°36.5'	0246	30	166	24.5	11	33	20.3	11.1	31.5	32.9
26	40°17.3'	72°37.6'	0642	30	113	22.2	13	52	20.2	8.8	31.7	33.2
26	39°58.5'	72°42.0'	1035	30	9	13.6	3	57	21.8	7.3	33.1	33.5
26	39°47.5'	72°33.5'	1346	30	36	6.4	10	64	21.6	8.5	33.0	33.8
26	39°47.8'	72°23.5'	1515	30	34	3.2	6	82	21.5	9.9	32.8	34.4
26	40°02.8'	72°17.0'	1723	30	28	11.8	7	75	21.0	8.9	33.1	33.9
26	39°49.0'	71°46.0'	2222	30	290	57.6	13	329	22.5	8.2	34.8	35.1
27	39°37.8'	71°59.0'	0049	30	107	11.8	11	262	21.8	9.0	34.1	35.1
27	39°34.5'	72°13.9'	0413	30	60	5.0	9	123	21.8	13.1	33.9	36.0
27	39°24.1'	72°16.2'	0606	30	22	8.6	5	227	21.6	18.5	33.6	35.7
27	39°11.0'	72°34.5'	1338	30	13	0.9	2	161	22.9	12.5	34.8	35.9
27	39°27.5'	72°49.0'	2030	30	102	8.6	10	62	22.7	8.4	33.6	33.7
28	39°52.0'	73°01.0'	0011	30	1044	135.6	15	60	22.3	7.3	32.5	33.2
28	40°04.3'	73°02.8'	0410	30	113	16.8	12	46	21.7	8.3	32.0	33.2
28	39°55.3'	73°18.2'	0613	30	545	122.5	12	51	21.6	9.0	32.1	33.2
28	39°53.0'	73°48.5'	0858	30	71	6.4	3	27	22.5	12.9	31.4	32.6
28	39°53.5'	74°02.5'	1132	30	797	5.0	6	15	22.1	16.2	31.0	31.9
28	39°56.3'	73°54.0'	1302	30	1211	27.2	4	22	22.4	13.5	31.4	32.4
28	39°59.4'	74°02.6'	1441	30	1190	39.9	13	15	22.2	15.7	30.9	31.8
28	40°04.2'	73°36.1'	1720	30	1451	86.6	12	42	23.5	10.7	30.0	33.0
28	40°14.0'	73°35.0'	2001	30	42	7.7	9	33	22.5	14.1	30.9	32.8
28	40°17.0'	73°39.0'	2115	30	41	9.5	8	27	22.1	14.1	28.5	32.4
28	40°24.0'	73°41.0'	2228	30	979	169.6	13	26	20.9	14.8	31.0	32.4
29	40°26.0'	73°41.0'	0012	30	920	156.9	9	27	21.3	14.5	**	**
29	40°23.0'	73°34.0'	0136	30	310	60.8	13	22	21.6	14.9	30.9	32.6
29	40°10.0'	73°51.0'	0448	30	1011	21.8	8	24	22.1	14.5	30.8	32.3
29	40°14.0'	73°48.0'	0612	30	166	18.6	7	33	22.3	13.9	31.0	32.5
29	40°17.5'	73°53.4'	0717	30	1144	33.6	12	30	21.2	16.5	29.5	32.0

Table 2.--Continued

Sta. No.	Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinit
		Lat.(N)	Long.(W)			No.	Wt.(kg)			Surface	Bottom	Surface
	Aug.											
121	14	40°29.1'	74°01.9'	0826	15	NO FISH CAUGHT			5	23.6	22.9	26.8
122	14	40°31.0'	74°01.2'	0904	15	5	2.3	3	5	25.5	22.9	27.0
123	14	40°33.4'	74°03.3'	1016	15	16	7.7	6	6	24.5	23.4	26.2
124	15	40°25.2'	74°00.5'	1115	15	39	0.5	4	6	27.0	24.5	26.3
125	15	40°26.1'	74°02.2'	1210	15	3	*	2	5	26.5	23.2	25.7
126	15	40°27.0'	74°03.9'	1255	15	33	*	3	5	25.5	23.5	26.1
127	21	40°32.2'	74°05.2'	0726	15	NO FISH CAUGHT			4	23.4	23.2	27.6
128	21	40°30.9'	74°05.2'	0807	15	71	0.5	2	3	23.5	22.8	26.6
129	21	40°30.8'	74°05.2'	0850	15	NO FISH CAUGHT			6	23.3	22.9	27.2
130	21	40°30.5'	74°09.1'	1051	15	18	0.5	2	6	24.3	24.0	27.5
131	21	40°28.7'	74°14.6'	1136	15	16	1.4	3	6	24.3	23.0	26.3
132	21	40°27.7'	74°09.9'	1254	15	4	8.6	1	4	24.9	24.5	25.6
133	22	40°29.4'	74°03.0'	0821	15	2	0.9	2	8	23.5	23.6	27.6
134	22	40°29.5'	74°06.2'	0905	15	5	3.6	5	9	23.8	23.6	27.6
135	22	40°27.1'	74°05.1'	1004	15	2	0.5	2	6	23.8	23.6	27.3
136	23	40°27.8'	74°01.3'	0812	15	116	7.3	6	7	23.8	23.8	27.6
137	16	40°32.0'	73°55.0'	1225	30	461	363.8	10	12	22.2	22.3	31.6
138	16	40°31.5'	73°53.5'	1358	30	474	86.6	11	11	22.7	22.0	30.8
139	16	40°33.3'	73°39.0'	1554	30	9970	37.6	11	16	22.5	21.1	31.6
140	16	40°31.8'	73°36.7'	1714	30	1869	36.3	13	20	22.5	19.1	31.7
141	16	40°26.0'	73°33.0'	1925	30	147	32.2	10	27	22.7	17.1	31.7
142	16	40°28.0'	73°26.3'	2052	30	244	37.6	14	24	21.4	17.1	32.7
143	16	40°33.0'	73°28.5'	2248	30	173	17.7	17	16	22.2	20.1	31.6
144	17	40°34.0'	73°23.0'	0004	30	485	38.6	17	18	22.3	19.8	31.6
145	17	40°31.0'	73°13.5'	0115	30	187	35.8	12	24	21.9	17.2	32.0
146	17	40°24.1'	73°05.2'	0407	30	78	21.8	9	40	21.2	10.9	32.6
147	17	40°33.8'	73°03.0'	0557	30	1136	47.2	9	29	21.8	13.8	32.1
148	17	40°37.5'	73°08.0'	0746	30	181	37.2	8	19	20.5	18.5	32.4
149	17	40°36.5'	72°55.0'	0925	30	55	17.7	10	30	**	13.9	32.3
150	17	40°42.0'	72°54.5'	1207	30	3146	48.1	19	15	21.4	17.8	32.3
151	17	40°43.5'	72°43.5'	1359	30	89	85.7	9	23	21.5	17.7	32.3
152	18	40°13.5'	72°36.5'	0122	30	499	117.0	15	54	21.8	8.4	32.8
153	18	40°13.7'	72°44.5'	0245	30	561	131.5	13	52	21.3	8.7	32.4
154	18	40°01.2'	73°00.6'	0547	30	26	8.6	8	49	21.7	8.5	32.2
155	18	39°55.5'	73°20.0'	0907	30	302	72.6	14	49	22.2	8.5	32.1
156	18	39°45.5'	73°15.0'	1045	30	655	30.4	12	45	22.3	10.7	32.5
157	18	39°46.0'	73°00.5'	1223	30	238	38.6	13	67	22.6	8.4	32.9
158	18	39°36.1'	72°42.6'	1538	30	64	12.7	10	72	22.5	8.9	33.5
159	18	39°47.8'	72°43.5'	1727	30	19	3.2	6	56	22.9	8.4	34.5
160	18	40°09.0'	72°20.0'	2148	30	398	143.8	11	68	22.6	9.6	33.9
161	19	39°55.5'	72°00.5'	0119	30	989	78.0	10	89	22.4	18.3	34.9
162	19	39°45.5'	71°58.4'	0318	30	397	24.5	12	146	23.3	13.5	35.7
163	19	39°40.8'	71°56.5'	0500	30	232	17.7	15	267	23.0	9.0	35.4
164	19	39°11.0'	72°27.5'	1319	30	362	21.8	19	330	23.9	7.8	35.1
165	19	39°17.8'	72°27.6'	1457	30	6	128.4	3	139	23.6	13.2	34.7
166	19	39°17.1'	72°37.5'	1751	30	1822	110.2	7	127	23.4	13.4	34.1
167	19	39°30.5'	73°03.0'	2235	30	388	40.4	14	66	22.2	8.1	33.2
168	20	39°46.0'	73°55.0'	0402	30	71	7.3	12	25	23.4	14.0	32.2
169	20	39°48.6'	74°01.0'	0515	30	264	6.8	3	17	21.4	16.2	32.0
170	20	39°56.3'	74°02.9'	0636	30	25	0.9	3	18	21.0	17.0	32.0
171	20	39°51.0'	73°57.0'	0813	30	83	2.3	6	21	23.0	14.4	32.2
172	20	40°01.0'	73°45.0'	1058	30	53	6.8	8	33	23.2	13.3	31.9
173	20	40°08.8'	73°57.0'	1240	30	107	1.4	3	17	23.2	16.3	31.7
174	20	40°10.0'	73°47.0'	1403	30	2653	74.8	7	33	23.9	13.1	**
175	20	40°10.0'	73°41.0'	1533	30	1832	111.1	10	49	23.7	9.2	32.3
176	20	40°03.5'	73°35.0'	1728	30	1585	68.5	7	42	23.2	10.8	32.0
177	20	40°13.6'	73°26.7'	2011	30	195	18.1	9	38	23.6	12.5	32.3
178	20	40°19.0'	73°36.0'	2140	30	383	10.9	10	26	23.4	15.4	32.1
179	20	40°23.0'	73°41.0'	2257	30	278	12.2	11	27	23.8	15.9	31.5

2.--Continued

Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity (o/oo)	
	Lat.(N)	Long.(W)			No.	Wt.(kg)			Surface	Bottom	Surface	Bottom
21	40°25.0'	73°41.0'	0002	30	112	8.6	7	28	23.9	15.3	31.6	33.0
21	40°23.0'	73°51.0'	0218	10	37	5.4	5	25	22.6	15.3	30.5	33.0
Sept.												
23	40°28.9'	74°05.3'	0915	15	200	2.7	6	8	19.8	19.5	**	**
23	40°29.4'	74°07.2'	1145	15	39	*	5	9	**	**	25.6	25.5
23	40°30.6'	74°05.9'	1301	15	610	3.6	8	8	19.0	19.5	24.6	25.1
23	40°26.7'	74°01.3'	1410	15	22	8.2	6	8	20.0	19.3	26.0	27.0
24	40°29.2'	74°01.5'	0801	15	89	3.2	8	5	18.2	18.3	25.8	25.7
24	40°33.3'	74°03.2'	0910	15	306	6.8	9	6	18.4	19.0	23.4	24.9
24	40°32.6'	74°05.5'	1030	15	985	6.4	4	5	18.6	18.4	23.8	24.8
24	40°30.5'	74°09.3'	1201	15	1441	9.5	8	6	18.7	18.5	25.3	25.4
24	40°28.6'	74°13.5'	1255	15	238	1.4	5	5	18.9	18.7	23.6	23.6
24	40°27.8'	74°08.8'	1348	15	30	0.9	4	3	19.4	18.9	24.0	24.1
25	40°26.4'	74°02.6'	0810	15	198	3.6	9	5	17.4	16.6	24.5	24.5
25	40°27.8'	74°05.0'	0913	15	74	8.2	8	6	18.8	18.5	24.9	24.9
23	40°29.0'	74°05.0'	0912	15	1865	11.8	8	7	19.8	19.5	**	**
23	40°29.0'	74°05.0'	1142	15	545	17.2	12	8	**	**	25.6	25.5
23	40°30.0'	74°05.0'	1258	15	30371	57.6	9	7	19.0	19.5	24.6	25.1
23	40°30.0'	73°53.0'	1449	30	621	131.1	13	12	18.9	16.5	30.1	32.2
23	40°31.9'	73°49.1'	1603	30	3451	93.4	19	11	18.8	16.4	30.8	32.5
23	40°33.9'	73°42.4'	1733	30	724	72.6	17	12	18.2	16.7	32.0	32.6
23	40°29.2'	73°40.1'	1851	30	228	147.9	16	18	18.2	12.9	31.5	32.6
23	40°17.8'	73°42.2'	2039	30	112	49.0	12	26	19.1	14.6	31.4	31.5
23	40°17.8'	73°37.7'	2152	30	179	66.2	16	25	**	**	31.4	32.5
23	40°15.0'	73°37.0'	2316	30	72	145.6	13	26	18.5	19.4	31.7	32.5
24	40°15.9'	73°34.8'	0058	30	135	57.6	16	25	18.2	16.9	31.5	32.5
24	40°19.6'	73°32.6'	0243	30	165	298.0	15	25	18.5	18.9	31.5	32.2
24	40°25.0'	73°31.7'	0421	30	313	57.2	16	25	18.4	18.4	31.6	32.4
24	40°28.8'	73°26.7'	0648	30	88	112.5	13	20	18.8	19.5	31.3	32.7
24	40°31.5'	73°29.2'	1020	30	14381	59.0	15	16	17.6	17.1	31.3	32.2
24	40°33.5'	73°25.0'	1130	30	2797	93.9	19	16	17.6	17.5	31.3	32.1
24	40°37.0'	73°11.8'	1333	30	8022	74.4	19	13	17.5	17.1	31.8	32.2
24	40°31.8'	73°08.4'	1728	30	1612	102.1	15	29	**	**	31.9	32.6
24	40°38.1'	73°05.4'	1850	30	1989	53.5	24	13	17.5	17.3	31.1	32.2
24	40°38.5'	72°55.0'	2021	30	215	158.3	10	26	17.5	17.1	32.0	32.7
24	40°40.8'	72°52.8'	2328	30	513	98.0	20	21	17.6	17.9	32.2	32.3
25	40°46.0'	72°40.5'	0113	30	12386	168.7	27	14	17.0	16.8	32.4	32.4
25	40°32.2'	72°31.0'	1013	30	172	24.5	11	43	17.5	14.3	32.7	33.1
25	39°59.0'	71°58.5'	2200	30	576	46.3	16	86	19.7	11.0	34.2	34.6
26	39°48.0'	71°50.5'	0134	30	324	13.6	17	21	19.6	11.3	34.9	35.4
26	39°39.0'	72°17.8'	0431	30	218	6.4	7	115	20.1	15.5	34.5	34.8
26	39°23.4'	72°21.6'	0635	30	39	6.4	2	141	21.0	12.6	34.8	35.7
26	39°13.0'	72°26.5'	1129	30	529	23.6	12	297	21.4	11.8	35.0	35.6
26	39°22.4'	72°29.2'	1334	30	107	9.5	4	131	**	**	34.8	35.7
26	39°43.7'	72°40.7'	1842	30	534	76.7	10	69	19.3	11.0	33.9	33.7
26	39°57.0'	72°35.0'	2154	30	412	78.5	11	60	18.7	10.8	33.6	33.2
26	40°06.5'	72°31.0'	2338	30	398	66.2	14	59	18.7	10.8	33.3	33.3
27	40°04.0'	72°39.0'	0058	30	537	176.0	16	60	18.7	10.4	33.4	33.0
27	40°09.5'	73°05.9'	0414	30	227	62.1	14	46	18.5	14.5	33.6	**
27	39°59.2'	73°19.0'	0618	30	3269	228.6	17	66	19.0	11.0	32.9	32.9
27	39°54.0'	73°19.5'	0755	30	186	46.3	11	49	19.0	10.4	32.1	32.8
27	39°46.5'	73°11.5'	1041	30	74	20.4	9	38	18.8	10.3	32.5	33.0
27	39°48.3'	73°22.0'	1211	30	19935	559.3	9	39	20.0	10.3	**	32.9
27	39°45.5'	74°03.4'	1722	30	427	157.9	17	13	19.9	19.1	30.8	31.7
27	39°48.4'	73°58.8'	1840	30	373	186.9	19	20	**	**	31.6	31.9
27	40°05.5'	74°00.0'	2220	30	369	98.8	12	18	**	**	31.6	32.1
27	40°04.0'	73°56.0'	2342	30	171	93.9	12	19	**	**	31.2	32.1
28	40°07.5'	73°48.8'	0143	30	275	113.4	16	33	**	**	31.6	32.3
Oct.												
22	40°28.9'	74°04.8'	0920	15	357	4.1	12	8	10.9	11.4	24.7	26.0
22	40°29.3'	74°06.6'	1030	15	543	2.7	11	9	10.4	11.4	24.4	25.6

Table 2.--Continued

Sta. No.	Date	Location Lat.(N)	Location Long.(W)	Start Time	Duration (min)	Total Catch No.	Total Catch Wt.(kg)	No. spp. Caught	Depth (m)	Temp. (°C) Surface	Temp. (°C) Bottom	Salinity Surface
239	22	40°29.9'	74°08.2'	1210	15	4714	2.7	5	9	11.8	11.2	24.1
240	22	40°30.6'	74°06.1'	1300	15	289	0.5	7	6	12.0	11.8	24.9
241	22	40°29.9'	74°03.9'	1339	15	18	0.5	4	8	12.4	11.7	24.5
242	23	40°27.9'	74°01.1'	0827	15	141	15.0	13	6	9.4	10.4	23.7
243	23	40°26.8'	74°02.4'	0919	15	42	5.0	6	6	9.5	10.2	22.9
244	23	40°27.9'	74°03.1'	1000	15	50	5.4	3	6	10.4	10.6	23.7
245	23	40°27.6'	74°05.1'	1145	15	485	0.5	3	5	10.7	10.5	23.8
246	23	40°27.4'	74°09.1'	1230	15	64	4.5	6	3	11.5	11.4	23.3
247	23	40°28.5'	74°11.1'	1300	15	25	0.9	3	4	12.3	11.6	22.9
248	23	40°28.7'	74°13.5'	1326	15	39	0.9	2	4	12.4	11.5	23.3
249	23	40°30.3'	74°09.9'	1407	15	81	2.7	5	6	12.4	10.6	24.9
250	24	40°25.9'	74°00.2'	0817	15	21	0.9	5	5	9.1	10.3	23.1
251	24	40°29.1'	74°01.3'	0910	15	83	0.5	4	5	11.6	11.7	24.8
252	24	40°31.1'	73°58.8'	1015	15	20	*	1	7	12.8	12.8	26.2
253	24	40°31.2'	74°01.2'	1127	15	11	*	2	5	12.6	12.4	24.8
254	24	40°33.8'	74°03.1'	1206	15	12	1.4	6	3	12.1	11.8	21.9
255	24	40°32.8'	74°05.3'	1250	15	13	4.5	2	4	11.8	11.5	24.6
256	22	40°29.0'	74°05.0'	0920	15	2392	32.2	18	8	10.9	11.4	24.7
257	22	40°29.0'	74°07.0'	1025	15	5339	22.2	12	7	10.4	11.4	24.4
258	22	40°29.0'	74°07.0'	1205	15	15499	32.7	15	5	11.8	11.2	24.1
259	22	40°28.0'	73°52.0'	1403	30	1063	355.2	19	18	13.6	13.5	30.9
260	22	40°31.0'	73°48.0'	1831	30	696	430.0	20	17	13.2	14.2	32.2
261	22	40°34.0'	73°47.0'	2009	30	341	465.4	20	12	12.9	13.5	31.7
262	22	40°34.0'	73°43.0'	2153	30	587	148.3	18	11	13.2	13.4	31.8
263	22	40°32.0'	73°36.8'	2359	30	520	109.8	20	14	13.3	13.4	31.9
264	23	40°28.2'	73°40.6'	0148	30	528	727.1	17	22	13.4	13.4	32.2
265	23	40°25.7'	73°36.9'	0335	30	451	435.4	15	20	14.0	14.2	32.1
266	23	40°24.0'	73°33.0'	0540	30	1272	626.4	23	26	14.0	14.2	32.0
267	23	40°10.0'	73°18.5'	0726	30	1069	335.7	11	36	14.8	14.7	32.5
268	23	40°28.6'	73°12.8'	1142	30	3385	390.1	15	28	13.8	14.4	32.5
269	23	40°27.5'	73°20.5'	1358	30	3531	248.1	12	25	14.2	14.6	32.1
270	23	40°32.5'	73°26.8'	1548	30	2600	65.3	18	16	14.7	14.6	31.9
271	23	40°32.0'	73°23.0'	1718	30	450	199.6	20	18	14.2	14.1	31.9
272	23	40°36.0'	73°16.0'	1905	30	903	75.3	26	16	13.4	13.4	31.7
273	23	40°37.5'	73°10.0'	2108	30	613	111.1	24	17	13.6	13.6	31.9
274	23	40°34.0'	73°09.0'	2255	30	888	430.4	23	23	13.6	13.6	32.0
275	24	40°39.0'	73°01.8'	0112	30	300	75.3	17	17	13.5	13.6	32.0
276	24	40°37.0'	72°55.3'	0230	30	2139	957.5	20	29	13.6	13.7	32.2
277	24	40°34.7'	72°49.0'	0434	30	979	656.3	16	33	14.2	14.4	32.8
278	24	40°46.0'	72°41.0'	0835	30	471	360.6	19	19	14.3	14.2	32.3
279	24	40°46.0'	72°33.0'	1027	30	816	1020.1	14	20	13.4	13.4	32.5
280	25	40°21.0'	72°40.5'	0250	30	481	95.7	18	48	14.2	12.4	33.0
281	25	40°08.5'	72°52.7'	0505	30	250	93.4	18	49	14.3	13.0	33.2
282	25	39°58.0'	72°47.0	0840	30	99	52.6	13	55	14.3	10.5	33.1
283	25	40°03.5'	72°30.0'	1038	30	108	56.7	11	59	15.0	10.5	33.1
284	25	40°07.0'	72°25.0'	1217	30	37	18.1	6	62	15.0	10.5	34.0
285	25	39°58.5'	72°05.6'	1817	30	63	19.5	8	81	14.7	11.3	**
286	26	39°43.0'	71°51.5'	0208	30	387	91.6	11	348	15.5	7.5	**
287	26	39°51.5'	71°48.5'	0624	30	12	8.6	5	165	15.4	13.2	**
288	26	39°46.0'	72°12.5'	0910	30	81	12.2	8	97	14.5	12.8	33.9
289	26	39°12.0'	72°26.5'	1750	30	139	20.0	17	288	15.5	8.6	34.7
290	26	39°14.5'	72°42.5'	2159	30	1344	86.6	12	113	15.8	14.8	34.7
291	27	39°37.0'	72°50.0'	0434	30	200	115.7	10	63	14.0	13.7	**
292	27	39°51.0'	73°01.5'	1035	30	187	190.5	10	75	14.0	10.5	33.2
293	27	39°52.5'	73°49.0'	1848	30	1084	939.4	20	15	14.1	14.3	**
294	27	39°50.0'	74°01.5'	2113	30	414	78.5	21	15	13.4	13.8	31.3
295	27	40°05.0'	73°55.0'	2222	30	1076	1225.2	17	22	13.4	14.3	31.7
296	28	40°05.0'	73°32.0'	0143	30	168	112.9	14	62	14.1	10.5	32.8
297	28	40°20.0'	73°44.0'	0516	30	2882	953.9	14	24	14.0	14.3	32.7
298	28	40°24.0'	73°57.0'	0828	30	5804	79.4	20	12	13.1	14.2	31.0

2.--Continued

Date	Location Lat.(N)	Location Long.(W)	Start Time	Duration (min)	Total Catch No.	Total Catch Wt.(kg)	No. spp. Caught	Depth (m)	Temp. (°C) Surface	Temp. (°C) Bottom	Salinity (o/oo) Surface	Salinity (o/oo) Bottom
Nov. 18	40°28.4'	74°04.1'	1037	15	134	5.4	11	8	10.5	9.8	**	27.1
18	40°29.1'	74°05.6'	1130	15	102	2.3	13	9	10.2	9.6	**	26.5
18	40°29.6'	74°08.1'	1314	15	71	1.8	9	8	10.4	10.1	**	26.8
18	40°29.1'	74°03.5'	1506	15	45	0.5	9	7	10.5	10.4	**	29.9
19	40°29.0'	74°01.5'	0906	15	16	4.5	7	5	9.8	9.8	**	27.4
19	40°31.1'	74°01.1'	0950	15	23	2.3	3	5	11.4	10.7	**	26.4
19	40°33.2'	74°00.2'	1035	15	5	0.5	3	5	13.4	10.6	**	30.4
19	40°33.3'	74°03.2'	1121	15	232	3.6	10	7	11.9	11.1	**	25.4
19	40°32.5'	74°05.2'	1212	15	15	1.4	6	5	12.8	11.2	**	25.2
19	40°30.5'	74°05.3'	1301	15	37	2.7	8	6	12.4	10.7	**	26.6
19	40°27.4	74°05.5'	1354	15	54	0.9	11	5	11.5	9.7	**	23.4
19	40°27.1'	74°03.2'	1441	15	71	5.4	11	5	11.1	10.6	**	28.3
19	40°27.5'	74°01.6'	1521	15	105	6.4	9	8	12.0	10.1	**	29.1
20	40°30.3'	74°09.1'	0947	15	65	3.6	9	5	10.0	9.5	**	25.2
20	40°28.4'	74°13.3'	1049	15	27	1.4	5	5	10.8	9.8	**	25.3
20	40°28.3'	74°11.5'	1126	15	86	3.2	9	5	10.8	9.4	**	25.7
20	40°27.5'	74°10.0'	1253	15	45	1.4	7	4	10.4	10.1	**	24.8
20	40°26.5'	74°02.5'	1353	15	135	9.5	9	6	10.7	10.1	**	28.8
20	40°25.2'	74°00.2'	1445	15	46	5.9	5	6	9.8	9.7	**	26.4
18	40°28.0'	74°04.0'	1033	15	533	33.1	18	8	10.6	9.7	23.8	27.0
18	40°29.0'	74°05.0'	1122	15	590	23.6	14	8	10.2	9.6	**	**
18	40°29.0'	74°08.0'	1310	15	945	53.5	18	8	10.4	10.1	25.5	26.9
18	40°30.2'	73°51.0'	1720	30	638	36.3	20	12	12.0	13.0	32.3	33.5
18	40°33.8'	73°51.0'	1910	30	645	63.5	22	8	12.1	12.4	33.2	33.1
18	40°34.0'	73°38.0'	2045	30	529	88.5	19	11	12.3	12.7	33.3	33.3
18	40°26.0'	73°27.0'	2235	30	349	149.9	25	26	12.1	12.4	33.1	33.1
19	40°35.5'	73°25.0'	0022	30	1130	190.5	26	8	10.5	10.9	32.2	32.1
19	40°36.0'	73°21.0'	0231	30	3089	151.0	18	13	11.5	11.3	32.0	32.0
19	40°37.0'	73°14.5'	0517	30	9898	235.9	21	15	10.5	10.3	32.3	32.2
19	40°21.5'	72°53.5'	0950	30	164	162.8	10	46	12.4	13.1	33.3	33.5
19	40°34.0'	72°57.5'	1146	30	171	77.6	19	30	12.0	12.4	32.4	32.9
19	40°39.0'	72°52.4'	1428	30	745	249.9	20	24	11.7	12.3	32.3	32.7
19	40°41.6'	72°55.0'	1620	30	565	124.3	17	15	10.9	11.0	32.3	32.3
19	40°46.0'	72°42.5'	1810	30	1574	248.1	17	10	11.1	13.3	32.4	32.6
19	40°49.5'	72°30.5'	1950	30	2280	452.7	17	10	11.8	11.5	32.9	32.6
19	40°49.5'	72°27.5'	2157	30	823	169.2	17	14	11.4	12.0	32.8	33.0
20	40°30.0'	72°30.0'	0953	30	303	254.0	17	46	12.7	13.1	33.4	33.7
20	40°00.8'	72°51.5'	1531	30	130	149.2	15	51	12.3	13.1	34.0	34.7
20	39°48.5'	72°31.5'	1935	30	334	193.2	17	67	12.9	13.7	**	**
20	39°57.5'	72°31.0'	2235	30	321	151.0	16	47	13.1	13.6	**	**
21	40°09.0'	72°20.5'	0036	30	200	113.4	12	68	12.9	13.1	34.1	34.1
21	40°11.2'	72°12.8'	0225	30	338	170.1	19	66	13.4	13.2	34.0	34.1
21	40°19.0'	73°35.0'	2204	30	261	181.9	15	26	11.1	11.3	32.8	32.8
23	40°03.5'	73°21.7'	0043	30	1089	555.2	16	45	10.8	12.4	33.4	34.0
23	39°57.0'	73°10.0'	0342	30	574	477.2	15	64	9.4	13.0	**	**
23	39°44.3'	71°53.5'	1700	30	299	45.8	11	237	13.5	**	34.6	35.7
23	39°48.0'	71°56.5'	1845		GEAR LOST			148	12.2	14.2	34.5	36.0
23	39°36.7'	72°25.5'	2230	30	808	283.0	15	335	13.4	11.4	34.8	35.9
24	39°26.8'	72°22.0'	0054	30	121	6.8	16	131	13.6	13.1	**	**
24	39°23.4'	72°36.0'	0400	30	298	8.6	12	112	13.5	13.9	35.0	35.8
24	39°28.5'	72°43.5'	0610	30	421	526.6	11	64	12.5	13.9	34.2	35.2
24	39°43.0'	73°03.5'	0932	30	194	114.8	9	50	12.3	13.2	34.3	34.4
24	39°46.0'	73°13.5'	1110	30	81	104.3	7	46	12.3	13.0	34.0	34.7
24	39°46.1'	73°58.8'	1622	30	198	478.1	13	20	11.4	11.5	32.8	32.7
24	40°01.0'	73°49.0'	1902	30	176	180.5	18	28	11.3	11.6	33.0	33.4
24	40°09.0'	73°50.8'	2032	30	177	145.6	19	24	10.7	12.1	32.7	33.9
24	40°16.0'	73°46.0'	2158		GEAR LOST			49	10.9	12.3	32.7	33.7
25	40°24.0'	73°41.0'	0042	30	212	108.4	15	24	11.1	11.0	32.5	33.2
25	40°08.5'	73°33.8'	0303	30	334	336.6	16	35	11.3	12.3	33.4	33.9

Table 2.--Continued

Sta. No.	Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity (
		Lat. (N)	Long. (W)			No.	Wt. (kg)			Surface	Bottom	Surface
	1975 Jan.											
358	3	40°29.1'	74°01.5'	1017	15	35	2.3	5	7	5.0	6.0	28.3
359	3	40°31.0'	74°01.2'	1058	15	27	1.8	6	7	6.1	6.0	28.4
360	3	40°33.3'	74°00.4'	1140	15	26	0.9	4	7	7.0	6.5	32.5
361	3	40°33.5'	74°03.1'	1314	15	36	0.9	9	5	6.0	6.0	26.3
362	3	40°32.5'	74°05.2'	1358	15	28	0.9	6	5	5.8	5.3	26.6
363	3	40°30.4'	74°05.4'	1435	15	20	*	3	7	5.8	5.2	26.1
364	6	40°25.2'	74°00.2'	0948	15	73	4.5	7	6	3.6	4.8	23.9
365	6	40°27.5'	74°01.1'	1045	15	112	1.8	4	6	4.5	6.3	24.5
366	6	40°27.1'	74°03.5'	1230	15	137	2.7	6	7	4.8	6.0	25.1
367	6	40°29.1'	74°03.0'	1307	15	31	0.5	3	7	5.4	6.2	25.6
368	6	40°29.3'	74°06.1'	1346	15	26	0.5	3	9	5.8	5.8	26.3
369	6	40°27.5'	74°05.6'	1433	15	25	0.5	4	7	5.4	5.8	26.2
370	9	40°28.3'	74°13.5'	1328	15	4	0.5	2	3	6.2	6.2	22.5
371	9	40°28.5'	74°11.0'	1404	15	68	2.3	8	3	6.2	5.9	24.8
372	31	40°28.5'	74°04.5'	0952	15	35	0.5	3	9	4.7	4.8	25.8
373	31	40°30.0'	74°07.5'	1218	15	92	1.4	6	9	4.8	4.7	26.5
374	31	40°29.0'	74°06.0'	1355	15	524	12.2	6	8	4.3	4.8	23.3
	Feb.											
375	3	40°27.2'	74°03.4'	1447	15	195	9.5	7	6	4.2	4.3	22.1
376	3	40°29.0'	74°01.5'	0935	15	36	0.9	7	5	4.0	4.2	24.1
377	3	40°31.1'	74°01.1'	1015	15	17	0.5	2	5	4.1	4.4	20.6
378	3	40°33.3'	74°00.0'	1058	15	2	*	1	6	4.4	4.5	23.9
379	3	40°33.5'	74°03.0'	1140	15	28	0.5	6	6	4.2	5.3	23.7
380	3	40°32.6'	74°03.0'	1307	15	NO FISH CAUGHT			5	4.1	4.3	23.9
381	3	40°30.3'	74°05.2'	1347	15	22	1.8	3	7	4.2	4.2	24.0
382	3	40°29.3'	74°04.0'	1429	15	2	*	1	8	4.2	4.3	22.9
383	4	40°28.2'	74°14.0'	1255	15	12	2.7	4	4	3.5	3.8	24.8
384	4	40°28.0'	74°12.0'	1330	15	13	*	1	6	2.9	3.4	22.7
385	4	40°30.3'	74°10.0'	1405	15	18	0.5	3	6	2.4	2.8	20.8
	Jan.											
386	31	40°29.0'	74°05.0'	0950	15	1815	24.0	10	10	4.7	4.8	25.8
387	31	40°29.0'	74°07.0'	1122	15	416	9.1	12	8	5.0	4.7	26.5
388	31	40°30.0'	71°08.0'	1216	15	1372	17.7	10	8	4.8	**	23.3
389	31	40°28.0'	73°50.0'	1415	30	815	70.8	11	17	6.4	7.3	32.1
390	31	40°34.0'	73°41.0'	1556	30	227	62.1	17	8	4.8	6.2	31.7
391	31	40°31.2'	73°37.3'	1728	30	277	67.6	15	17	5.8	6.0	32.7
392	31	40°29.8'	73°36.7'	1958	30	662	150.6	17	20	6.0	7.2	32.7
393	31	40°26.0'	73°36.5'	2155	30	481	89.4	19	22	5.5	7.0	32.4
394	31	40°29.3'	73°31.0'	2335	30	426	60.8	14	23	5.6	6.4	32.4
	Feb.											
395	1	40°32.5'	73°27.0'	0108	30	522	62.1	14	19	5.6	6.2	32.2
396	1	40°25.0'	73°24.3'	0230	30	671	133.4	14	29	5.0	6.0	32.4
397	1	40°24.2'	73°15.3'	0355	30	414	176.9	16	31	5.0	5.9	33.0
398	1	40°11.5'	73°15.0'	0545	30	409	142.4	16	38	5.6	6.8	33.3
399	1	40°32.0'	73°13.0'	0928	30	421	59.9	15	21	5.0	5.4	32.6
400	1	40°36.0'	73°16.5'	1044	30	553	68.5	16	15	5.0	5.2	34.4
401	1	40°39.5'	73°02.3'	1232	30	423	147.0	14	15	5.0	5.3	32.2
402	1	40°37.2'	73°01.0'	1346	30	318	82.1	14	22	5.2	4.8	32.1
403	1	40°40.0'	72°53.0'	1504	30	243	79.8	12	27	3.8	5.0	32.5
404	1	40°44.0'	72°48.5'	1741	30	431	101.2	11	15	3.8	4.5	32.4
405	1	40°47.1'	72°29.5'	1940	30	510	131.1	16	24	4.1	5.3	32.7
406	2	40°36.1'	72°32.5'	0523	30	473	126.6	10	40	5.2	5.8	33.4
407	2	40°26.2'	72°44.8'	0723	30	153	76.7	10	44	6.0	6.8	33.7
408	2	40°05.0'	72°45.0'	1256	30	214	234.5	6	55	8.4	8.4	34.3
409	2	40°16.5'	72°17.8'	1549	30	181	199.1	9	57	8.2	8.5	34.1
410	2	40°04.0'	72°02.0'	2055	30	517	169.7	17	76	7.6	10.4	34.2
411	3	39°44.2'	71°56.9'	0619	30	27	10.4	4	172	11.2	13.7	36.0
412	3	39°52.0'	71°45.0'	0945	30	32	5.0	4	219	8.1	11.5	34.8
413	3	39°58.3'	72°08.7'	1408	30	109	49.9	13	82	8.2	11.2	34.2
414	3	39°56.4'	72°20.2'	1630	30	189	99.3	11	74	8.8	10.2	34.6
415	3	39°51.5'	72°44.0'	2312	30	332	223.2	14	69	8.2	9.0	34.5

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ate	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity (o/oo)	
	Lat.(N)	Long.(W)			No.	Wt.(kg)			Surface	Bottom	Surface	Bottom
4	39°45.6'	72°38.0'	0115	30	316	143.8	14	62	8.8	9.0	34.6	34.3
4	39°36.0'	72°24.0'	0348	30	116	70.8	12	283	8.2	9.1	34.2	36.1
4	39°33.4'	72°12.4'	0742	30	45	8.6	2	134	11.6	13.1	36.8	36.9
4	39°30.0'	72°26.0'	0925	30	6	1.8	1	126	8.9	12.9	34.3	35.9
4	39°09.1'	72°32.8'	1648	30	162	29.5	13	342	12.8	9.3	36.1	35.7
4	39°26.0'	72°57.5'	2224	30	287	132.4	11	59	8.5	8.9	34.7	34.7
5	39°38.0'	72°45.3'	0158	30	509	304.4	15	69	8.5	9.3	34.2	34.6
5	39°46.2'	73°07.0'	0426	30	267	519.4	7	47	8.5	8.4	34.5	34.5
5	39°55.6'	73°14.0'	0807	30	781	537.1	9	75	7.4	8.2	**	**
5	39°45.0'	73°27.5'	1150	30	101	65.8	6	33	7.8	7.2	**	**
5	39°40.5'	74°04.1'	1614	30	113	26.3	12	16	5.0	5.0	32.9	**
5	39°46.3'	73°58.4'	1855	30	297	67.6	12	21	5.3	5.1	**	**
5	39°52.0'	74°03.0'	2034	30	433	86.2	11	15	5.4	5.2	**	**
5	39°54.5'	74°01.0'	2212	30	342	58.1	13	16	5.4	5.3	32.0	32.6
6	39°59.0'	73°52.5'	0151	30	240	72.1	19	24	6.2	**	32.8	**
6	40°04.5'	73°55.0'	0314	30	258	64.0	14	23	6.2	6.6	33.2	**
6	39°57.5'	73°35.4'	0520	30	196	79.4	16	30	6.4	5.4	33.8	**
6	40°16.0'	73°33.0'	0925	30	478	136.5	13	27	5.4	5.4	32.8	33.0
6	40°13.0'	73°35.0'	1127	30	403	114.3	14	28	5.7	5.8	33.2	33.3
6	40°10.6'	73°38.6'	1257	30	418	124.3	12	36	5.9	6.0	33.3	**
6	40°11.0'	73°47.0'	1448	30	510	132.0	11	35	6.2	6.0	33.3	33.3
6	40°16.0'	73°45.0'	1558	30	955	289.8	20	31	5.9	6.0	33.0	33.0
6	40°16.5'	73°54.0'	1736	30	244	57.2	12	21	5.4	5.8	30.3	33.3
6	40°21.8'	73°48.1'	1926	30	118	11.8	26	37	5.7	6.1	32.3	33.7
Mar.												
6	39°51.5'	71°45.0'	1112	30	321	85.7	14	207	7.1	9.8	34.9	36.4
6	39°48.5'	71°48.0'	1318	30	209	135.6	13	229	7.6	9.4	34.8	35.5
6	40°01.5'	71°53.5'	1600	30	309	75.3	10	84	7.8	10.3	34.8	35.7
6	40°34.5'	72°21.5'	2315	30	227	64.0	11	44	6.2	7.5	34.2	34.6
7	40°16.5'	72°12.0'	0206	30	264	107.5	12	61	6.9	6.8	34.9	34.9
7	40°19.5'	72°48.0'	0524	30	362	88.9	12	48	5.1	6.4	34.8	34.6
7	40°09.5'	73°10.0'	0752	30	34	22.7	10	41	5.2	5.7	34.8	35.0
7	39°59.0'	72°33.0'	1144	30	279	300.7	11	66	7.3	7.3	35.5	35.6
7	39°45.0'	72°34.5'	1449	30	268	137.0	9	79	7.5	7.3	35.5	35.6
7	39°33.5'	72°13.0'	1728	30	93	9.1	12	135	7.9	11.3	35.6	**
7	39°20.0'	72°20.5'	2310	30	108	8.6	13	169	8.0	12.5	35.4	36.6
8	39°26.0'	72°27.5'	0129	30	66	6.8	15	122	7.5	12.1	35.4	36.5
8	39°50.5'	72°59.0'	1327	30	797	1326.8	9	71	7.7	7.7	35.4	35.4
8	39°53.5'	73°06.0'	1519	30	386	446.8	9	68	6.7	7.4	34.8	**
8	39°50.5'	73°21.0'	1751	30	326	131.1	11	44	6.4	6.5	34.8	34.8
8	39°47.0'	73°09.0'	1928	30	409	127.9	10	46	7.1	7.1	35.0	35.4
8	39°36.5'	72°54.5'	2131	30	479	792.4	6	64	7.3	7.3	35.4	35.5
8	39°29.0'	72°52.0'	2313	30	145	161.0	6	65	8.3	8.3	35.5	35.8
10	39°12.0'	72°28.5'	0225	30	127	50.3	18	302	9.0	10.8	35.7	36.2
18	40°30.2'	73°46.5'	1735	30	114	27.7	8	18	5.0	5.0	32.9	34.0
18	40°34.5'	73°43.0'	2006	30	211	64.0	10	9	4.6	4.6	32.5	32.5
18	40°32.1'	73°33.1'	2244	30	209	36.7	13	16	4.4	4.4	32.7	32.7
19	40°32.8'	73°27.2'	0218	30	142	37.2	13	15	4.4	4.4	33.0	32.8
19	40°29.3'	73°24.7'	0312	30	150	31.8	13	25	4.3	4.3	32.9	32.9
19	40°25.0'	73°24.8'	0450	30	110	33.1	12	27	4.3	4.4	33.1	33.1
19	40°24.4'	73°32.8'	0633	30	15	7.3	6	22	4.5	4.5	32.4	**
20	40°24.9'	73°55.1'	0732	30	54	10.0	7	17	5.2	5.1	**	32.1
20	40°19.3'	73°53.2'	0855	30	53	24.9	10	19	5.2	4.8	28.9	32.2
20	40°17.5'	73°56.0'	1054	30	NO FISH CAUGHT			18	5.2	4.7	29.3	31.7
20	40°12.6'	73°59.6'	1336	30	NO FISH CAUGHT			13	5.0	4.9	32.2	32.2
20	40°06.5'	74°04.7'	1500	30	101	24.0	10	22	5.3	5.0	31.6	32.7
21	40°02.0'	74°02.0'	1120	30	74	20.9	8	16	5.1	5.0	32.2	31.7
21	39°57.3'	73°57.0'	1306	30	25	11.3	6	21	5.5	5.1	31.8	31.6
21	39°50.0'	73°56.7'	1515	30	23	9.5	7	20	5.6	5.1	31.9	32.4
21	39°49.5'	74°04.8'	1717	30	95	36.7	11	8	5.4	5.3	32.0	32.0
21	39°42.5'	73°57.0'	1905	30	81	23.1	9	22	5.3	5.2	32.3	32.1

Table 2.--Continued

Sta. No.	Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity (
		Lat.(N)	Long.(W)			No.	Wt.(kg)			Surface	Bottom	Surface
476	22	39°47.5'	73°48.0'	1912	30	31	20.4	11	24	5.2	5.1	33.2
477	22	40°05.5'	73°50.0'	2220	30	52	13.2	9	24	5.3	4.8	32.6
478	23	40°17.8'	73°42.7'	1900	30	79	25.4	8	24	5.1	4.9	33.5
479	23	40°24.7'	73°34.7'	2059	30	206	55.8	12	24	5.0	4.8	33.6
480	23	40°35.1'	73°20.7'	2340	30	196	31.3	13	16	5.2	4.8	33.0
481	24	40°32.7'	73°08.4'	0201	30	54	23.1	8	26	5.3	4.9	33.1
482	24	40°37.2'	73°01.1'	0344	30	55	22.2	9	22	5.3	4.9	33.0
483	24	40°40.7'	72°56.9'	0521	30	39	7.3	8	17	5.0	4.8	33.0
484	24	40°47.7'	72°37.2'	0744	30	144	84.4	16	6	5.0	4.8	33.3
485	24	40°47.5'	72°28.5'	0917	30	22	10.4	10	26	5.1	4.8	33.2
	Apr.											
486	1	40°28.0'	74°01.0'	1125	15	21	3.2	6	7	6.5	5.7	20.6
487	1	40°27.0'	74°02.0'	1235	15	14	1.8	7	11	7.5	6.0	20.6
488	1	40°27.2'	74°03.4'	1315	15	4	*	3	6	6.6	6.0	21.2
489	1	40°29.0'	74°03.4'	1400	15	10	1.4	5	7	6.4	6.5	23.0
490	1	40°29.6'	74°03.4'	1415	15	4	0.5	2	5	6.8	6.5	22.4
491	1	40°31.0'	74°01.0'	1450	15	5	1.8	2	5	**	**	22.1
492	2	40°25.0'	74°00.5'	0915	15	2	*	2	5	6.4	5.5	20.5
493	2	40°30.1'	74°05.0'	1030	15	49	2.3	3	6	6.5	5.8	20.4
494	2	40°30.1'	74°06.0'	**	15	11	0.5	4	6	6.3	5.3	21.2
495	2	40°30.4'	74°09.0'	1218	15	2	0.5	2	5	6.8	5.3	23.0
496	2	40°28.6'	74°11.0'	1300	15	102	0.9	3	5	6.2	4.5	20.3
497	2	40°28.6'	74°13.0'	1445	15	73	0.5	4	4	6.5	5.0	19.3
498	7	40°33.5'	74°00.0'	1244	15	1	*	1	3	5.5	5.4	23.8
499	7	40°33.4'	74°03.0'	1328	15	2	*	2	9	5.3	5.0	19.3
500	7	40°32.4'	74°05.2'	1406	15	57	1.4	5	5	4.7	4.5	20.3
501	1	40°27.3'	73°46.4'	1747	30	175	33.6	10	27	5.0	5.5	29.8
502	1	40°30.0'	73°38.0'	1939	30	214	68.5	11	16	5.5	5.1	30.3
503	1	40°31.6'	73°38.7'	2046	30	269	49.9	13	16	5.5	5.2	29.9
504	1	40°32.5'	73°33.4'	2208	30	303	91.6	12	15	5.2	5.0	31.4
505	1	40°32.0'	73°26.0'	2326	30	310	50.3	12	18	5.2	4.5	32.2
506	2	40°18.5'	73°11.5'	0205	30	162	68.9	11	38	4.8	4.9	33.1
507	2	40°32.5'	73°11.0'	0500	30	274	59.4	12	24	4.8	4.7	32.4
508	2	40°32.5'	73°07.5'	0626	30	207	100.7	9	24	5.0	4.8	32.4
509	2	40°37.0'	73°09.0'	0750	30	126	41.7	13	13	4.8	4.6	32.5
510	2	40°40.0'	72°59.0'	0922	30	103	64.9	11	17	4.7	4.7	32.5
511	2	40°43.5'	72°49.5'	1329	30	214	66.2	14	16	5.0	5.0	32.5
512	2	40°45.4'	72°36.0'	1540	30	121	62.6	13	26	5.3	4.9	32.7
513	2	40°32.0'	72°29.0'	2326	30	151	86.2	14	46	5.3	5.3	**
514	3	40°24.0'	72°33.5'	0157	30	216	131.1	10	49	5.7	7.2	33.1
515	3	40°13.5'	72°32.0'	0457	30	219	214.1	9	57	6.3	6.1	**
516	3	40°19.0'	72°59.5'	0747	30	64	52.2	9	44	5.7	5.6	33.5
517	5	40°01.0'	74°02.0'	1248	30	59	15.9	8	17	4.8	4.8	32.4
518	5	39°52.5'	74°03.5'	1446	30	112	22.2	11	16	4.8	4.8	32.3
519	5	39°54.5'	73°59.5'	1601	30	27	22.7	10	18	4.9	4.9	32.7
520	5	40°00.0'	73°56.0'	1744	30	367	13.2	6	20	5.4	5.4	33.4
521	5	40°08.8'	73°55.0'	2108	30	175	35.8	14	18	4.6	5.0	32.1
522	5	40°13.5'	73°48.0'	2337	30	267	87.1	20	31	5.4	5.4	33.5
523	6	40°15.9'	73°33.8'	0329	30	173	28.1	6	29	4.4	4.4	32.4
524	6	40°00.0'	73°38.0'	0828	30	44	27.2	9	36	4.8	6.3	33.0
525	6	39°52.5'	73°29.0'	1125	30	43	62.6	11	38	5.6	6.3	33.8
526	6	40°03.5'	73°17.0'	1426	30	41	17.7	6	46	5.4	5.4	33.0
527	6	40°08.8'	72°55.6'	1831	30	93	106.1	9	47	5.9	5.9	33.7
528	7	40°03.5'	73°24.0'	0224	30	119	127.0	7	68	6.0	6.5	33.7
529	7	40°14.0'	72°09.0'	0540	30	185	383.7	11	66	5.3	5.3	33.7
530	7	40°09.0'	72°01.5'	0822	30	58	122.0	5	69	5.6	6.6	33.8
531	7	39°46.4'	71°49.4'	1518	30	142	32.2	12	311	7.0	8.8	34.0
532	7	39°43.0'	72°07.0'	1912	30	48	15.4	6	112	7.4	11.8	34.3
533	7	39°44.0'	72°14.5'	2322	30	51	51.3	10	104	7.5	11.2	34.2

e 2.--Continued

ate	Location		Start	Duration	Total Catch		No. spp.	Depth	Temp. (°C)		Salinity (o/oo)	
	Lat.(N)	Long.(W)	Time	(min)	No.	Wt.(kg)	Caught	(m)	Surface	Bottom	Surface	Bottom
8	39°47.5'	72°21.0'	0113	30	57	57.2	8	82	6.6	10.6	34.0	35.5
8	39°45.5'	72°39.0'	0554	30	271	225.9	12	75	6.7	7.4	33.9	34.1
8	39°34.0'	72°20.0'	0725	30	64	8.6	4	101	7.5	11.2	34.0	35.5
8	39°29.5'	72°19.0'	1015	30	117	20.4	20	366	7.5	11.8	34.2	35.7
8	39°14.0'	72°27.0'	1855	30	174	37.6	16	183	8.1	11.6	34.6	35.7
8	39°11.5'	72°37.0'	2112	30	46	8.2	14	139	8.0	12.3	34.5	35.7
8	39°19.0'	72°48.5'	2323	30	70	30.8	12	79	7.5	9.2	34.4	34.8
9	39°28.5'	72°58.5'	0354	30	179	205.9	6	66	6.6	6.6	34.0	34.1
9	39°34.1'	73°05.5'	0540	30	92	122.0	12	47	6.5	6.5	34.0	34.0
9	39°52.5'	72°51.0'	1030	30	155	120.7	11	64	6.6	6.6	34.0	34.0
9	39°54.5'	73°11.5'	1554	30	259	233.1	12	62	6.1	6.1	34.0	33.8
9	39°46.0'	73°10.0'	1854	30	259	156.5	13	46	8.6	8.4	33.9	33.9
10	40°26.2'	73°37.0'	0608	30	122	37.2	16	20	4.9	4.9	32.6	32.7
10	40°18.5'	73°49.0'	0912	30	44	14.5	9	38	4.9	6.1	32.4	34.6
10	40°16.3'	73°50.8'	1054	30	NO	FISH CAUGHT		26	5.0	5.0	32.5	32.5
May												
5	40°28.5'	74°05.0'	**	15	8	1.4	4	7	11.4	10.8	21.5	21.6
5	40°29.2'	74°06.1'	**	15	14	1.8	5	8	10.9	11.4	21.3	21.6
5	40°30.1'	74°05.5'	**	15	13	1.4	2	7	11.5	10.4	21.2	23.0
5	40°30.5'	74°09.0'	**	15	5	0.5	2	4	11.2	10.9	20.8	20.7
6	40°29.1'	74°01.6'	**	15	34	*	4	5	11.0	10.2	19.7	27.7
6	40°33.5'	74°00.1'	**	15	56	2.7	7	4	11.4	10.4	17.7	24.1
6	40°33.6'	74°03.1'	**	15	25	0.9	8	5	12.3	12.2	23.1	19.1
6	40°32.6'	74°05.2'	**	15	72	2.3	11	4	13.9	11.6	19.3	20.4
6	40°28.5'	74°13.5'	**	15	55	4.1	7	4	15.0	14.1	14.9	21.2
6	40°28.4'	74°11.6'	**	15	161	15.4	8	4	14.9	13.6	16.1	21.2
6	40°27.5'	74°10.0'	**	15	47	3.2	7	3	14.5	13.3	16.3	20.4
6	40°27.5'	74°04.0'	**	15	58	10.4	9	5	**	**	20.9	23.9
8	40°29.1'	74°03.1'	**	15	47	9.5	8	7	12.7	11.5	19.9	22.6
8	40°27.6'	74°01.5'	**	15	78	14.5	5	7	12.1	13.2	20.2	21.0
8	40°26.5'	74°02.1'	**	15	127	17.7	4	5	14.4	12.3	19.9	20.8
8	40°25.2'	74°00.6'	**	15	85	7.3	8	5	14.8	14.0	20.1	20.9
5	40°28.8'	74°04.4'	1026	15	181	18.1	11	8	11.4	10.8	21.5	21.6
5	40°29.2'	74°06.2'	1111	15	211	17.7	11	9	10.9	11.4	21.3	21.6
5	40°29.3'	74°06.5'	1152	15	456	76.2	13	8	11.5	10.4	21.2	23.0
5	40°29.8'	73°54.0'	1350	30	1127	110.2	25	12	9.3	9.5	32.2	32.7
5	40°32.0'	73°48.0'	1519	30	329	91.2	16	15	8.6	8.5	32.7	32.6
5	40°34.2'	73°45.5'	1635	30	1708	198.7	22	11	9.0	8.9	32.7	32.7
5	40°29.6'	73°45.1'	1802	30	353	98.9	15	26	8.4	8.2	32.7	32.8
5	40°28.2'	73°35.8'	2004	30	721	83.0	17	21	8.3	8.0	32.9	33.0
5	40°25.3'	73°44.0'	2133	30	423	69.4	12	24	8.2	6.4	32.9	33.0
5	40°18.8'	73°37.0'	2308	30	445	51.7	13	26	7.8	6.7	33.1	33.3
6	40°15.4'	73°40.8'	0031	30	518	190.1	15	30	8.0	6.5	33.3	33.3
6	40°14.0'	73°45.0'	0203	30	508	106.5	13	50	8.4	6.3	33.0	33.2
6	40°17.8'	73°51.1'	0652	30	584	166.9	21	26	8.4	7.3	28.7	33.0
6	40°11.3'	73°49.0'	0835	30	360	123.4	17	26	8.8	7.0	31.0	33.1
6	40°11.5'	73°56.0'	0948	30	346	91.2	16	17	9.4	7.7	26.1	32.5
6	40°22.9'	73°55.8'	1503	30	364	71.2	18	15	10.8	7.5	26.9	32.9
6	40°30.0'	73°31.2'	1658	30	549	144.7	17	20	8.5	7.9	32.9	33.0
6	40°32.5'	73°29.0'	1936	30	625	121.1	16	17	8.5	8.3	32.8	32.0
6	40°34.0'	73°22.7'	2052	30	918	154.7	17	17	8.5	8.3	32.5	32.6
6	40°29.3'	73°18.9'	2226	30	461	214.1	18	24	7.7	7.7	32.0	32.6
7	40°19.5'	73°22.5'	0010	30	593	144.2	18	33	8.0	6.8	32.8	33.0
7	40°14.8'	73°16.5'	0210	30	326	98.9	16	39	7.8	6.1	32.7	33.4
7	40°27.0'	73°06.7'	0545	30	200	92.5	17	31	7.8	7.4	32.7	32.8
7	40°31.9'	73°07.4'	0705	30	407	215.4	17	24	7.6	7.6	32.3	32.4
7	40°36.3'	73°13.0'	0828	30	927	397.3	17	18	8.4	8.1	32.1	32.2
7	40°37.0'	73°09.0'	1028	30	1087	273.5	19	18	9.0	8.0	32.0	32.2
7	40°34.4'	73°00.5'	1158	30	129	144.7	18	23	8.5	7.5	32.1	32.6
7	40°39.5'	72°59.3'	1314	30	511	230.0	15	17	8.5	7.4	31.9	32.0
7	40°44.9'	72°44.7'	1609	30	675	226.8	18	18	9.5	7.6	**	**
7	40°44.6'	72°42.2'	1800	30	630	202.8	20	25	8.5	7.2	31.7	31.8

Table 2.--Continued

Sta.		Location		Start	Duration	Total Catch		No. spp.	Depth	Temp. (°C)		Salinit
No.	Date	Lat.(N)	Long.(W)	Time	(min)	No.	Wt.(kg)	Caught	(m)	Surface	Bottom	Surface
595	7	40°41.5'	72°37.0'	1948	30	460	137.4	14	32	7.8	6.9	31.8
596	7	40°28.5'	72°31.8'	2141	30	175	68.5	11	43	8.5	6.0	**
597	8	40°27.0'	72°27.0'	0023	30	198	83.9	13	47	7.5	5.6	32.4
598	8	40°21.7'	72°45.4'	1653	30	117	69.4	14	49	8.2	5.7	32.5
599	8	40°13.7'	72°59.0'	1851	30	107	49.9	14	47	9.3	5.6	32.6
600	8	40°01.1'	72°53.0'	2040	30	319	111.1	12	50	8.5	6.0	33.0
601	9	40°11.5'	72°32.7'	0033	30	1065	433.6	13	62	9.5	5.9	32.6
602	9	40°16.5'	72°07.3'	0300	30	164	53.1	12	62	7.3	5.4	33.3
603	9	40°03.8'	72°19.5'	0910	30	322	112.0	11	72	7.3	5.5	33.3
604	9	39°43.8'	72°00.6'	1612	30	74	34.9	14	153	9.5	11.9	34.0
605	9	39°52.5'	71°44.0'	2042	30	248	75.3	19	222	8.7	10.7	33.5
606	9	40°02.0'	71°55.2'	2255	30	50	14.5	10	83	9.0	5.6	33.6
607	10	39°55.2'	72°08.8'	0046	30	37	13.6	10	80	8.7	5.4	33.5
608	10	39°54.0'	72°41.3'	0430	30	101	42.6	18	54	9.0	5.9	33.5
609	10	39°46.2'	72°21.1'	0646	30	126	33.1	12	88	8.8	5.6	33.1
610	10	39°37.3'	72°22.8'	0816	30	103	17.2	10	105	8.5	11.5	33.5
611	10	39°30.4'	72°09.0'	1152	30	373	63.5	13	248	10.8	11.4	34.3
612	10	39°24.6'	72°14.4'	1348	30	314	93.9	15	348	10.6	9.0	34.2
613	10	39°14.5'	72°29.4'	1932	30	74	11.3	14	155	9.6	11.5	34.1
614	10	39°28.5'	72°43.0'	2335	30	39	15.9	7	70	9.2	5.7	32.6
615	11	39°40.4'	72°46.3'	0154	30	195	93.0	15	68	9.9	6.0	33.4
616	11	39°28.1'	73°05.6'	0540	30	217	90.7	14	65	9.5	6.2	33.3
617	11	39°38.2'	73°17.8'	1118	30	36	35.4	10	39	11.2	6.8	33.7
618	11	39°43.0'	73°01.8'	1310	30	49	25.4	13	51	11.2	6.2	33.3
619	11	39°54.0'	73°07.5'	1500	30	644	219.5	18	70	10.9	6.5	33.1
620	11	39°53.7'	73°27.1'	1821	30	98	50.8	14	41	11.9	6.2	32.1
621	11	39°54.0'	73°39.3'	1952	30	417	85.3	15	28	11.1	6.2	31.8
622	11	39°54.5'	73°49.0'	2125	30	443	212.3	17	27	11.4	6.3	31.3
623	12	39°52.5'	73°52.7'	0015	30	418	146.5	18	24	11.0	6.5	31.8
624	12	39°40.7'	74°05.4'	0233	30	301	116.6	17	15	11.3	8.8	31.6
625	12	39°47.6'	74°01.9'	0404	30	263	91.2	16	17	11.0	7.9	31.5
626	12	39°54.7'	74°03.4'	0528	8	332	117.9	18	18	9.4	8.1	32.2
627	12	40°04.0'	73°20.0'	1210	30	64	56.7	12	42	11.6	6.3	32.7
	June											
628	3	40°27.6'	74°03.1'	0805	15	116	3.2	10	7	20.6	20.4	20.1
629	3	40°27.5'	74°05.1'	0840	15	57	2.3	9	5	20.8	20.5	19.4
630	3	40°27.6'	74°09.1'	0930	15	37	1.8	5	3	20.4	19.4	20.0
631	3	40°28.3'	74°11.0'	0950	15	17	1.4	6	4	20.3	19.2	21.3
632	3	40°28.5'	74°13.0'	1025	15	2	*	2	3	**	**	19.5
633	3	40°30.3'	74°09.6'	**	15	21	0.5	5	5	**	**	22.2
634	9	40°29.1'	74°01.4'	0920	15	7	0.9	4	5	17.3	17.0	23.2
635	9	40°31.1'	74°01.1'	1040	15	16	0.5	4	5	16.9	16.5	24.4
636	9	40°32.2'	74°05.9'	1235	15	50	0.9	5	4	18.1	17.9	23.8
637	2	40°31.0'	73°54.7'	1623	30	243	68.0	10	10	16.5	15.0	30.7
638	2	40°31.0'	73°50.7'	1746	30	584	131.1	18	16	18.2	9.6	28.9
639	2	40°34.0'	73°39.8'	1915	30	531	106.6	16	9	15.9	13.5	31.7
640	2	40°27.3'	73°36.6'	2048	30	147	37.6	18	19	17.8	9.5	29.9
641	2	40°25.0'	73°41.0'	2210	30	289	86.2	18	24	17.6	8.6	30.3
642	2	40°22.3'	73°30.4'	2356	30	312	74.8	18	26	17.8	7.4	30.6
643	3	40°27.0'	73°35.2'	0115	30	339	114.8	16	22	17.8	10.0	30.2
644	3	40°32.0'	73°31.3'	0239	30	1124	264.0	14	15	17.2	12.8	30.9
645	3	40°35.1'	73°21.1'	0424	30	572	90.3	16	18	16.3	9.0	31.4
646	3	40°36.0'	73°16.7'	0634	30	249	122.9	10	18	16.6	8.2	31.4
647	3	40°33.0'	73°13.0'	0815	30	74	49.9	9	23	17.7	7.7	30.7
648	3	40°34.0'	73°08.5'	0937	30	107	105.7	10	21	17.6	7.5	31.0
649	3	40°37.0'	73°09.0'	1050	30	260	99.8	13	17	15.3	8.2	31.8
650	3	40°41.2'	72°56.5'	1225	30	752	136.1	17	15	16.7	8.8	31.4
651	3	40°39.3'	72°55.7'	1344	30	204	195.0	13	25	**	**	31.5
652	3	40°30.5'	72°49.3'	1635	30	117	51.3	10	38	16.0	7.0	31.6
653	3	40°43.6'	72°42.7'	1826	30	717	372.9	12	25	15.9	6.6	31.3

ble 2.--Continued

Date	Location		Start Time	Duration (min)	Total Catch		No. spp. Caught	Depth (m)	Temp. (°C)		Salinity (o/oo)	
	Lat. (N)	Long. (W)			No.	Wt. (kg)			Surface	Bottom	Surface	Bottom
4	40°31.2'	72°23.1'	0346	30	177	59.0	14	46	15.7	5.4	31.7	33.0
4	40°46.8'	72°38.2'	0617	30	416	117.5	18	18	13.5	11.2	31.8	32.1
4	40°18.5'	72°19.5'	2130	30	70	28.6	7	55	16.5	5.4	31.9	33.1
4	40°16.0'	72°23.5'	2238	30	69	31.8	7	55	16.0	8.7	31.9	33.1
5	40°23.5'	72°55.0'	0216	30	222	56.2	9	41	15.0	5.7	31.4	33.0
5	40°21.0'	73°14.7'	0505	30	99	20.4	16	33	17.5	6.7	31.1	32.6
5	40°11.0'	73°17.2'	0720	30	56	15.0	14	37	16.6	6.0	31.2	33.1
5	40°03.8'	73°11.2'	0852	30	50	10.9	10	41	16.6	6.0	31.5	33.3
5	39°51.0'	73°13.5'	1055	30	329	20.0	9	46	16.7	6.0	31.6	33.3
5	39°58.5'	73°07.0'	1353	30	56	15.4	7	48	16.6	5.7	32.2	33.3
5	39°56.1'	72°50.8'	1556	30	18	4.5	4	54	16.7	5.8	32.4	33.3
5	40°01.6'	72°41.6'	1736	30	87	30.4	12	58	16.1	5.6	32.3	33.2
5	40°13.5'	72°43.5'	2035	30	312	122.0	10	54	15.7	5.3	31.8	33.1
5	40°09.8'	72°27.8'	2237	30	183	68.0	10	57	15.7	5.7	32.0	33.2
4	40°11.3'	72°13.6'	0111	30	122	48.5	10	68	15.4	5.8	32.7	33.3
6	39°44.3'	71°52.5'	1247	30	135	30.4	11	264	13.8	10.0	33.2	35.7
6	39°56.2'	71°50.5'	1618	30	149	25.4	11	113	16.9	12.1	34.5	35.3
6	39°54.5'	71°57.5'	1750	30	428	72.6	10	99	17.5	11.7	34.8	35.3
6	40°06.0'	71°55.6'	1946	30	245	82.1	11	77	14.3	12.0	32.8	33.9
6	39°58.9'	72°16.4'	2206	30	205	83.0	11	77	15.2	8.1	32.8	33.0
7	39°46.7'	72°27.5'	0133	30	358	97.1	10	75	16.3	7.7	32.6	33.7
7	39°36.0'	72°10.9'	0506	30	117	17.2	12	125	14.8	12.1	33.3	35.7
7	39°32.5'	72°22.0'	0723	30	29	3.2	9	210	15.3	9.0	33.5	35.4
7	39°16.0'	72°22.0'	1130	30	48	2.3	11	225	18.8	11.5	35.4	35.7
7	39°12.4'	72°40.3'	1654	30	93	19.1	11	127	17.4	11.2	33.3	35.2
7	39°26.5'	72°44.2'	1857	30	201	73.0	7	74	16.8	9.1	32.5	34.5
8	39°34.1'	72°47.6'	0006	30	119	49.4	7	66	17.0	5.8	32.4	33.3
8	39°41.3'	72°50.8'	0232	30	145	50.8	9	67	16.7	7.3	39.1	33.4
8	39°41.1'	73°11.2'	0646	30	26	19.1	6	43	16.6	7.2	31.2	32.8
8	39°45.2'	73°53.8'	1149	30	86	35.4	10	24	18.3	8.2	31.4	32.7
8	39°43.0'	74°02.0'	1318	30	98	61.7	11	17	17.4	9.1	30.2	32.4
8	39°58.6'	74°02.5'	1556	30	433	137.0	16	17	17.3	9.5	29.1	32.3
8	39°56.4'	73°38.5'	1915	30	120	19.5	11	31	15.8	7.7	31.4	32.7
8	40°04.5'	73°50.7'	2102	30	347	73.5	19	24	**	**	31.3	32.5
8	40°00.5'	73°54.0'	2235	30	511	136.1	18	21	16.4	8.4	31.1	32.5
9	40°05.3'	74°00.8'	0010	30	630	161.5	16	20	16.8	11.0	28.4	31.3
9	40°10.7'	73°57.0'	0145	30	1014	238.1	16	17	16.7	10.5	30.4	32.3
9	40°12.0'	73°49.9'	0338	30	220	104.8	15	27	16.7	8.4	31.2	32.4
9	40°13.7'	73°45.8'	0527	30	296	146.1	19	63	16.2	6.4	31.3	33.0
9	40°11.7'	73°43.9'	0706	30	410	157.9	16	57	16.0	6.3	33.0	31.2
9	40°12.4'	73°37.0'	0837	30	299	134.7	17	71	15.6	6.0	31.3	33.2
9	40°08.5'	73°30.5'	1116	30	73	28.1	14	38	15.9	6.6	31.1	32.8
9	40°15.6'	73°34.5'	1251	30	76	32.7	11	26	15.9	8.4	31.3	32.4
9	40°17.0'	73°38.0'	1403	30	67	29.0	15	24	16.5	8.1	30.9	31.2
9	40°18.0'	73°42.8'	1509	30	41	33.1	11	28	16.5	8.8	31.0	32.2
9	40°15.8'	73°50.7'	1640	30	193	117.0	14	25	16.9	8.7	31.3	32.5
9	40°23.6'	73°57.1'	1834	30	393	167.8	16	12	16.7	12.5	27.0	27.3

Table 3.--List of fishes collected in New York Bight, June 1974 to June 1975, arranged according to Bailey et al. (1970), including number and weight by station of occurrence; i.e., station number (number of fish; weight in kg). An asterisk (*) indicates a weight of less than 0.5 kg.

MYXINIDAE

Myxine glutinosa, Atlantic hagfish
100(8; 0.5)   101(1; *)   163(1; *)   286(2; *)   289(5; 0.5)   346(1; *)
417(3; *)   440(1; *)   458(3; 0.5)

LAMNIDAE

Carcharodon carcharias, white shark
138(1; 23.6)

SCYLIORHINIDAE

Scyliorhinus retifer, chain dogfish
348(1; 0.5)   414(1; *)   538(1; *)   604(1; 0.5)   610(8; 2.3)   612(2; 0.5)
670(5; 0.9)   675(1; *)   678(1; *)

CARCHARHINIDAE

Mustelus canis, smooth dogfish
19(5; 14.1)   20(3; 6.8)   21(3; 5.0)   23(4; 16.8)   24(10; 24.9)
27(2; 4.1)   28(2; 2.3)   30(2; 7.7)   37(8; 0.9)   45(4; 11.3)
46(2; 4.5)   47(4; 13.2)   48(7; 14.1)   49(5; 14.1)   50(6; 13.6)
52(8; 19.5)   53(4; 9.5)   61(9; 15.0)   65(12; 5.0)   66(5; 3.6)
68(2; 0.9)   71(2; 1.4)   72(2; 1.4)   77(31; 39.5)   78(1; 1.4)
79(5; 3.6)   80(4; 10.9)   81(1; 2.7)   82(3; 6.8)   83(4; 10.4)
84(32; 73.5)   85(14; 32.2)   88(1; 3.6)   89(1; 3.2)   90(1; 0.9)
91(3; 8.2)   92(1; 0.9)   116(3; 8.2)   117(2; 5.9)   118(1; 3.6)
120(2; 5.0)   123(3; 2.7)   137(130; 300.3)   138(27; 42.2)   140(1; 1.8)
141(2; 5.4)   142(8; 17.2)   143(2; 4.1)   144(10; 21.8)   145(5; 13.2)
146(3; 6.4)   148(13; 33.1)   150(5; 6.4)   151(33; 74.8)   162(1; *)
186(1; 1.4)   187(1; 0.9)   197(36; 85.3)   198(21; 50.8)   199(6; 15.0)
200(49; 123.4)   201(11; 36.7)   202(14; 44.5)   203(34; 100.2)   204(12; 31.8)
205(87; 268.1)   206(68; 4.5)   207(339; 90.7)   208(10; 14.1)   209(4; 6.4)
211(18; 54.9)   212(2; 4.1)   213(24; 74.8)   214(6; 20.0)   215(1; 1.4)
216(1; 1.8)   232(43; 129.7)   233(51; 94.3)   234(24; 60.3)   235(23; 63.0)
236(21; 64.9)   277(1; 2.3)   288(2; 0.5)   294(6; 15.0)   298(4; 13.6)
340(1; 0.5)   583(1; 1.4)   589(1; 4.1)   625(2; 3.6)   626(1; 1.4)
637(15; 19.5)   638(6; 15.4)   639(3; 3.2)   642(4; 12.7)   643(1; 1.8)
644(5; 10.4)   645(2; 3.2)   646(12; 29.5)   647(3; 7.7)   648(4; 16.8)
649(9; 20.4)   650(4; 5.4)   651(11; 31.3)   653(13; 30.4)   655(3; 3.6)
659(1; 2.7)   678(1; *)   683(1; 2.7)   684(10; 26.8)   685(6; 12.2)
686(2; 4.1)   687(1; 2.7)   688(2; 4.1)   689(1; 2.3)   691(3; 6.4)
693(1; 1.8)   695(1; 2.3)   696(3; 7.3)   697(2; 5.0)   698(4; 16.3)
699(9; 22.7)   700(17; 30.4)

SQUALIDAE

Squalus acanthias, spiny dogfish
18(3; 14.5)   20(4; 18.6)   21(3; 13.2)   22(1; 5.0)
23(3; 7.3)   24(7; 24.9)   25(8; 32.2)   27(2; 8.6)
30(4; 13.6)   44(1; 4.1)   47(3; 13.6)   49(1; 2.3)
50(4; 19.1)   51(6; 23.1)   52(11; 44.0)   53(8; 30.8)
54(1; 5.0)   55(1; 4.1)   59(3; 12.2)   60(3; 12.2)
259(121; 230.9)   260(208; 385.1)   261(154; 447.2)   262(16; 49.9)
263(28; 85.3)   264(283; 698.5)   265(138; 410.5)   266(168; 538.0)

e 3.--Continued

qualus acanthias--Cont.

267(96; 248.1)	268(105; 212.7)	269(106; 215.0)	270(5; 15.4)
271(56; 162.8)	272(2; 7.3)	273(29; 69.9)	274(107; 363.8)
275(22; 50.3)	276(216; 857.3)	277(161; 492.1)	278(102; 290.3)
279(332; 957.5)	280(2; 5.0)	281(11; 20.9)	282(12; 23.1)
283(6; 13.6)	284(2; 5.9)	291(18; 31.3)	292(14; 49.0)
293(324; 851.8)	294(3; 9.5)	295(490; 1151.2)	296(26; 73.0)
297(339; 900.8)	298(3; 7.3)	321(2; 3.2)	323(5; 11.3)
324(3; 5.4)	326(1; 1.4)	327(2; 4.1)	328(35; 111.6)
329(23; 58.5)	330(11; 23.6)	331(7; 15.4)	332(7; 15.4)
333(2; 5.4)	334(4; 12.2)	335(134; 192.8)	336(35; 95.3)
337(71; 102.5)	338(4; 11.8)	340(1; 4.5)	341(41; 114.3)
342(86; 275.6)	343(38; 298.9)	346(6; 11.3)	348(4; 4.5)
349(207; 414.1)	350(23; 57.2)	351(29; 83.0)	352(110; 412.8)
353(37; 136.5)	354(25; 38.6)	356(28; 58.5)	357(178; 38.6)
397(1; 4.1)	398(3; 8.2)	406(5; 14.5)	407(3; 11.3)
408(184; 213.2)	409(116; 171.9)	410(231; 88.0)	413(9; 10.9)
414(48; 47.2)	415(71; 108.9)	416(131; 78.0)	417(3; 8.2)
421(51; 83.0)	422(197; 200.0)	423(188; 485.8)	424(302; 339.3)
425(14; 33.6)	430(1; 3.6)	432(14; 27.7)	433(4; 15.0)
434(3; 11.8)	435(1; 4.1)	440(9; 7.3)	441(5; 2.7)
442(37; 16.8)	443(5; 14.5)	444(38; 61.7)	445(4; 5.4)
446(2; 6.4)	447(118; 249.9)	448(165; 100.7)	449(2; 2.7)
450(3; 1.8)	451(3; 1.4)	452(579; 1264.2)	453(250; 412.8)
454(28; 63.0)	455(51; 120.7)	456(344; 753.0)	457(78; 127.5)
458(11; 15.9)	472(1; 3.6)	473(1; 3.6)	476(2; 7.3)
481(1; 3.2)	513(13; 38.6)	515(45; 146.1)	516(4; 11.3)
518(1; 3.2)	519(3; 10.0)	524(3; 10.4)	525(3; 12.7)
527(23; 76.7)	528(33; 89.4)	529(129; 345.6)	530(42; 115.7)
531(4; 3.6)	532(2; 2.3)	533(8; 31.3)	534(14; 43.1)
535(66; 152.0)	536(3; 4.5)	540(5; 10.9)	541(49; 154.7)
542(31; 94.3)	543(39; 80.3)	544(56; 170.6)	545(27; 70.3)
546(2; 6.8)	572(4; 14.1)	573(1; 4.1)	574(3; 11.3)
575(20; 88.5)	576(6; 25.9)	578(3; 11.3)	579(1; 3.6)
581(13; 54.0)	582(3; 7.3)	583(10; 37.2)	584(21; 77.1)
585(3; 5.9)	586(5; 5.9)	587(8; 31.8)	588(19; 82.6)
589(19; 72.6)	590(18; 64.9)	591(27; 106.6)	593(1; 3.2)
594(5; 15.0)	595(2; 9.1)	596(3; 8.2)	597(2; 2.7)
598(2; 6.8)	599(3; 7.3)	601(2; 6.8)	602(4; 10.9)
603(1; *)	605(7; 1.8)	608(7; 4.5)	609(76; 8.2)
611(1; 0.9)	612(1; *)	615(2; 5.5)	616(17; 13.2)
617(6; 21.8)	618(3; 5.4)	619(25; 9.5)	620(5; 15.4)
621(1; 4.1)	622(21; 88.9)	623(2; 8.6)	624(8; 30.4)
625(1; 4.1)	626(1; 6.4)	627(8; 31.3)	638(7; 29.5)
639(1; 3.2)	640(3; 12.2)	641(7; 25.9)	642(2; 9.1)
643(6; 23.6)	644(38; 84.4)	645(1; 5.0)	646(1; 5.0)
647(5; 18.1)	648(15; 58.5)	649(1; 4.1)	651(26; 101.2)
653(25; 104.3)	671(2; 0.5)	672(7; 4.1)	674(16; 1.8)
678(1; *)	681(1; *)	688(1; 5.4)	690(4; 17.2)
691(7; 30.4)	698(1; 3.6)	699(6; 26.8)	700(6; 28.6)

EDINIDAE

rpedo nobiliana, Atlantic torpedo

23(1; 8.6)   61(2; *)

RAJIDAE

Raja eglanteria, clearnose skate
111(1; 1.4) 138(1; 1.4) 143(3; 1.4) 150(7; 3.6) 198(3; 2.7) 205(1; 1.8)
206(2; 3.2) 232(1; 1.8)

Raja erinacea, little skate
19(1; 0.5) 25(5; 2.3) 22(2; 0.9) 28(2; 0.5) 29(2; 0.9)
30(2; 0.9) 31(1; 0.5) 41(2; 0.9) 42(3; 1.4) 43(2; 0.9)
44(5; 1.8) 45(7; 3.2) 46(9; 3.2) 54(1; 0.5) 56(11; 4.5)
57(13; 4.5) 58(15; 5.0) 59(20; 6.4) 60(8; 3.2) 70(106; 50.8
81(4; 1.8) 82(86; 31.8) 83(59; 28.1) 84(12; 6.4) 85(27; 14.5)
86(393; 125.2) 87(59; 22.7) 88(2; 0.9) 89(10; 5.0) 90(15; 9.5)
91(9; 4.5) 92(91; 45.8) 93(64; 14.1) 94(6; 2.7) 95(1; 0.5)
96(3; 1.4) 98(1; 0.5) 104(6; 2.3) 105(187; 72.1) 106(14; 5.4)
107(365; 105.7) 108(15; 5.4) 110(7; 3.6) 112(108; 32.2) 113(20; 5.9)
114(6; 2.3) 115(235; 98.4) 116(177; 73.0) 117(39; 17.7) 118(19; 8.2)
119(32; 10.4) 120(29; 13.6) 140(1; 0.5) 141(26; 12.7) 142(18; 10.0)
145(48; 17.7) 146(44; 12.7) 147(23; 10.0) 148(5; 2.3) 149(27; 12.7)
151(17; 10.4) 152(125; 47.6) 153(208; 76.2) 154(11; 4.5) 155(140; 50.8)
156(28; 10.9) 157(36; 19.1) 158(13; 6.4) 159(3; 1.4) 160(156; 88.0)
161(14; 5.9) 167(46; 12.7) 168(10; 3.6) 170(1; *) 171(1; 0.5)
172(15; 0.9) 173(1; *) 174(35; 10.4) 175(116; 42.6) 176(16; 5.9)
177(27; 10.0) 178(5; 1.4) 179(3; 1.4) 198(1; 0.5) 200(8; 4.1)
201(19; 8.6) 202(5; 1.8) 203(11; 5.9) 204(5; 2.7) 205(5; 4.5)
206(5; 1.8) 207(3; 1.4) 208(9; 4.1) 209(1; 0.5) 210(4; 2.3)
211(61; 32.2) 212(2; 0.5) 213(115; 65.3) 214(95; 49.4) 215(64; 42.6)
216(45; 18.1) 217(1; *) 223(46; 23.1) 224(107; 35.8) 225(82; 29.0)
226(282; 127.0) 227(105; 44.9) 228(61; 30.8) 229(101; 38.1) 230(35; 14.5)
231(26; 10.0) 236(25; 10.9) 260(9; 4.5) 261(4; 1.8) 262(3; 1.4)
263(14; 7.7) 264(22; 12.2) 265(5; 2.3) 266(17; 9.1) 267(74; 30.8)
268(35; 15.9) 269(9; 4.5) 270(5; 2.3) 271(4; 1.8) 272(28; 17.2)
273(52; 27.2) 274(47; 20.0) 275(19; 10.0) 276(116; 53.1) 277(258; 100.7)
278(88; 45.8) 279(35; 16.3) 280(189; 60.8) 281(94; 44.9) 282(24; 11.8)
283(44; 24.0) 284(3; 0.9) 285(6; 4.1) 291(100; 61.7) 292(123; 112.
293(118; 48.5) 294(69; 30.4) 295(20; 24.5) 296(66; 29.0) 297(41; 20.0)
298(8; 5.0) 321(15; 7.3) 322(14; 8.6) 323(31; 16.3) 324(149; 64.9)
325(152; 82.1) 326(142; 63.0) 327(134; 64.0) 328(47; 25.9) 329(12; 5.4)
330(346; 122.0) 331(43; 22.2) 332(192; 66.2) 333(213; 79.8) 334(193; 79.4
335(83; 39.0) 336(42; 23.1) 337(47; 23.1) 338(128; 76.2) 339(151; 81.2
340(126; 70.8) 341(112; 32.2) 342(808; 249.0) 343(207; 88.9) 349(51; 31.8)
350(68; 39.5) 351(36; 19.5) 352(1; 0.5) 353(21; 7.3) 354(8; 3.6)
356(62; 24.9) 357(139; 73.0) 389(19; 8.6) 390(24; 12.7) 391(15; 7.3)
392(20; 11.3) 393(96; 34.0) 394(41; 15.4) 395(37; 14.1) 396(172; 56.7
397(174; 80.7) 398(172; 71.2) 399(30; 8.2) 400(15; 7.3) 401(45; 26.3)
402(5; 1.8) 403(24; 11.3) 404(165; 57.2) 405(168; 49.9) 406(116; 39.5
407(60; 29.5) 408(22; 12.2) 409(33; 19.1) 410(46; 24.5) 413(3; 1.8)
414(54; 29.0) 415(111; 51.7) 416(72; 33.1) 417(8; 3.6) 421(112; 40.8
422(131; 61.2) 423(48; 25.4) 424(7; 4.1) 425(18; 8.6) 426(16; 5.4)
427(66; 25.4) 428(93; 34.5) 429(90; 31.8) 430(44; 17.7) 431(52; 21.8)
432(40; 15.4) 433(262; 75.3) 434(196; 51.7) 435(101; 33.1) 436(22; 6.8)
437(542; 170.1) 438(74; 25.9) 439(1; 0.5) 443(24; 6.4) 444(35; 14.5)
445(21; 9.1) 446(1; 0.5) 447(1; 0.9) 452(73; 20.0) 453(11; 4.1)
454(4; 1.8) 455(14; 7.3) 456(17; 9.1) 457(26; 20.4) 458(3; 0.5)
459(5; 2.3) 460(27; 13.2) 461(48; 18.1) 462(40; 14.1) 463(33; 10.0)
464(55; 19.1) 465(7; 4.5) 466(4; 1.8) 467(14; 6.4) 470(22; 9.1)

3.--Continued

ja erinacea--Cont.

471(9; 4.1)	472(11; 5.0)	473(8; 3.6)	474(11; 5.0)	475(40; 13.6)
476(15; 5.9)	477(8; 2.7)	478(50; 14.5)	479(57; 20.0)	480(40; 12.2)
481(30; 8.2)	482(33; 12.7)	483(15; 3.2)	484(55; 29.5)	485(5; 3.2)
501(4; 1.8)	502(48; 23.6)	503(40; 16.8)	504(76; 24.5)	505(79; 21.3)
506(55; 19.5)	507(81; 20.9)	508(95; 36.7)	509(17; 6.4)	510(30; 14.5)
511(48; 24.0)	512(19; 8.6)	513(46; 20.4)	515(75; 36.7)	516(9; 4.5)
517(2; 0.5)	518(1; 0.5)	520(2; 0.9)	521(2; 8.2)	522(41; 14.1)
523(63; 15.0)	524(18; 5.4)	525(12; 5.9)	526(6; 2.7)	527(12; 5.9)
528(62; 27.7)	529(28; 10.4)	530(9; 4.1)	534(7; 5.0)	535(33; 18.6)
540(12; 7.7)	541(77; 38.6)	542(14; 8.6)	543(49; 21.3)	544(50; 25.9)
545(38; 20.0)	546(2; 0.9)	547(9; 3.2)	568(18; 9.1)	569(13; 6.8)
570(63; 26.8)	571(19; 8.2)	572(29; 11.3)	573(94; 40.4)	574(55; 16.8)
575(51; 21.3)	576(75; 25.9)	577(37; 11.8)	578(36; 13.6)	579(29; 12.2)
580(41; 14.1)	581(23; 8.6)	582(52; 17.7)	583(94; 29.0)	584(170; 60.3)
585(198; 68.5)	586(105; 34.0)	587(47; 20.4)	588(82; 28.6)	589(336; 111.6)
590(225; 69.4)	591(32; 11.8)	592(268; 50.3)	593(71; 66.7)	594(175; 70.3)
595(185; 72.6)	596(73; 120.7)	597(91; 48.1)	598(9; 5.0)	599(28; 13.6)
600(184; 64.0)	601(293; 122.0)	602(63; 23.1)	603(51; 29.0)	606(2; 1.4)
607(9; 6.8)	608(36; 20.4)	609(5; 3.6)	614(14; 9.5)	615(80; 48.5)
616(71; 37.6)	617(9; 4.5)	618(10; 5.4)	619(198; 88.0)	620(24; 10.9)
621(238; 70.3)	622(246; 83.5)	623(226; 76.2)	624(75; 34.0)	625(57; 23.6)
626(13; 6.4)	627(8; 3.2)	637(7; 3.6)	638(23; 11.8)	639(2; 0.5)
640(17; 7.3)	641(73; 25.9)	642(68; 25.9)	643(59; 25.9)	644(19; 9.1)
645(7; 2.7)	646(4; 1.8)	647(23; 9.1)	648(17; 6.4)	649(7; 1.8)
650(30; 14.5)	651(23; 8.2)	652(32; 16.3)	653(340; 146.5)	654(54; 24.5)
655(82; 27.2)	656(34; 15.9)	657(41; 17.2)	658(82; 32.2)	659(18; 7.7)
660(19; 9.1)	661(14; 6.4)	662(9; 5.4)	663(27; 11.8)	664(8; 4.1)
665(41; 17.7)	666(205; 84.4)	667(136; 55.8)	668(77; 33.6)	669(5; 1.8)
671(3; 1.8)	672(14; 9.5)	673(34; 19.1)	674(29; 16.8)	679(14; 8.6)
680(56; 24.9)	681(83; 41.3)	682(9; 3.6)	683(31; 10.4)	684(26; 12.2)
685(40; 20.0)	686(17; 5.4)	687(101; 37.2)	688(153; 64.0)	689(103; 48.1)
690(66; 27.2)	691(60; 24.0)	692(76; 28.1)	693(273; 5.0)	694(74; 49.9)
695(33; 14.1)	696(35; 12.7)	697(27; 12.2)	698(6; 1.8)	699(100; 40.8)
700(21; 10.0)				

ia garmani, rosette skate

101(1; 0.5)	165(2; 0.9)	219(1; 0.5)	288(1; *)	290(1; *)	347(3; 0.9)
411(1; 0.5)	418(2; 0.9)	450(1; 0.5)	539(1; 0.5)	604(6; 1.4)	610(8; 2.7)
613(1; *)	675(2; 0.5)	676(1; 0.5)	678(6; 1.8)	680(1; *)	

ia laevis, barndoor skate

346(2; 15.0)

a ocellata, winter skate

228(1; 1.8)	233(9; 12.7)	234(1; 6.4)	259(1; *)	325(6; 24.5)
326(2; 15.0)	327(1; 2.3)	330(1; 5.9)	331(3; 10.9)	332(2; 9.1)
333(13; 46.3)	335(1; 1.8)	342(1; 1.8)	354(1; 5.4)	356(1; 1.4)
390(8; 18.1)	391(3; 5.9)	392(5; 6.4)	393(3; 12.7)	395(3; 5.9)
397(3; 10.9)	399(1; 1.4)	400(3; 8.2)	401(10; 42.2)	402(6; 20.9)
404(3; 5.4)	405(3; 10.9)	432(1; 6.4)	438(1; 3.6)	454(2; 17.2)

Table 3.--Continued

Raja ocellata--Cont.
461(1; 2.3) 462(1; 2.7) 465(1; 1.4) 480(1; 1.4) 481(1; 5.4)
482(2; 4.1) 484(2; 7.7) 502(2; 5.9) 503(1; 2.3) 504(1; 3.6)
505(1; 2.7) 506(1; 4.1) 508(1; 5.4) 511(1; 2.7) 512(2; 6.4)
513(1; 6.8) 515(1; 5.4) 521(3; 9.1) 524(1; *) 525(1; 2.7)
527(1; 4.5) 545(1; 7.7) 568(3; 13.2) 569(2; 6.8) 570(3; 9.1)
575(1; 5.0) 578(1; 5.0) 579(1; 5.0) 581(1; 3.2) 582(1; 1.8)
583(2; 5.4) 584(4; 21.8) 586(1; 3.6) 588(1; 4.1) 589(3; 6.8)
590(1; 5.4) 591(1; 3.2) 592(8; 33.1) 593(6; 23.1) 594(3; 8.6)
621(1; 1.8) 622(1; 5.4) 623(1; 5.0) 637(3; 5.9) 639(1; 2.3)
650(2; 5.4) 651(1; 2.3) 665(1; 5.0) 688(1; 0.5) 692(1; 2.3)
693(1; 2.3)

Raja radiata, thorny skate
286(4; 0.9) 348(17; 6.8) 417(8; 31.8) 537(2; 0.9) 538(1; *) 612(5; 0.9)
655(1; *)

DASYATIDAE
Dasyatis centroura, roughtail stingray
137(1; 7.7) 203(2; 38.1) 204(1; 15.4) 205(1; 17.7) 209(1; 15.4)

ACIPENSERIDAE
Acipenser oxyrhynchus, Atlantic sturgeon
651(1; 5.9)

ANGUILLIDAE
Anguilla rostrata, American eel
327(1; 0.5) 357(1; *)

SIMENCHELYIDAE
Simenchelys parasiticus, snubnose eel (See: Leim and Scott 1966)
422(1; *)

CONGRIDAE
Conger oceanicus, conger eel
204(1; *) 215(1; *) 286(1; *) 319(1; *) 324(1; *) 353(1; *)
487(1; 0.5) 558(1; *) 560(1; 0.5) 570(1; *) 572(1; *) 670(2; 1.8

OPHICHTHIDAE
Pisodonophis cruentifer, snake eel (See: Rosenblatt and McCosker 1970)
33(2; *) 104(6; *) 106(3; *) 115(1; *) 152(2; *) 155(1; *)
158(1; *) 160(4; *) 161(2; *) 164(2; *) 168(2; *) 217(1; *)
218(1; *) 224(7; *) 225(3; *) 226(4; *) 227(4; *) 228(1; *)
291(1; *) 293(1; *) 325(1; *) 338(3; *) 340(4; *) 341(3; *)
347(2; *) 348(1; *) 410(1; *) 420(1; *) 451(1; *) 615(1; *)

NEMICHTHYIDAE
Nemichthys scolopaceus, slender snipe eel
417(1; *) 608(1; *) 609(1; *) 612(5; *)

e 3.--Continued

EIDAE

osa aestivalis, blueback herring

16(300; 2.3)	17(140; 0.9)	18(1032; 6.8)	27(2; *)	28(7; 0.5)
29(5; 0.9)	50(1; *)	53(3; *)	61(53; 0.9)	150(2; *)
256(1; *)	258(29; 0.5)	300(6; *)	301(5; *)	302(1; *)
306(3; *)	308(1; *)	309(1; *)	313(9; *)	314(3; *)
315(9; *)	318(138; 5.9)	319(264; 7.3)	320(80; 15.4)	358(1; *)
359(19; 0.9)	360(1; *)	361(2; *)	362(1; *)	364(10; *)
365(41; 0.5)	366(26; 0.5)	367(22; 0.5)	368(8; *)	371(25; *)
373(67; 0.5)	374(26; *)	375(31; *)	376(1; *)	379(1; *)
381(15; 0.5)	385(15; *)	386(2; 0.5)	392(2; *)	393(33; 5.4)
399(25; 0.5)	400(102; 0.9)	401(2; *)	402(1; *)	454(1; *)
484(1; *)	488(2; *)	493(31; 0.9)	494(7; *)	495(2; *)
496(97; 0.9)	497(70; 0.5)	500(43; 0.5)	509(1; *)	522(1; *)
546(13; 1.4)	547(1; *)	550(4; *)	552(3; *)	553(3; *)
554(35; *)	555(2; *)	556(10; *)	557(2; *)	561(1; *)
564(10; *)	565(9; 1.8)	566(9; 1.8)	568(8; 0.9)	577(1; *)
580(1; *)	590(3; *)	593(1; *)	628(1; *)	629(1; *)
630(1; *)	632(1; *)	633(2; *)	638(3; *)	641(3; 0.5)
655(22; 1.4)	659(7; 0.9)	692(4; 0.5)	693(2; *)	694(21; 4.1)

osa mediocris, hickory shad

17(2; 0.5)

osa pseudoharengus, alewife

16(40; 0.9)	17(328; 42.6)	19(1; *)	20(1; *)	21(1; *)
28(1; *)	48(1; *)	53(163; 4.5)	61(1; *)	70(3; *)
238(4; *)	246(2; *)	249(1; *)	256(9; 0.5)	257(8; 0.5)
258(1; *)	282(1; 0.5)	299(24; 0.9)	300(34; 0.9)	301(2; *)
306(140; 1.8)	309(1; *)	311(28; 1.4)	313(8; *)	314(7; *)
315(4; *)	317(1; *)	320(4; *)	322(7; *)	325(2; *)
326(1; *)	358(23; 0.9)	361(6; *)	362(1; *)	363(3; *)
364(21; 0.5)	365(20; 0.5)	366(19; 0.5)	367(3; *)	368(12; *)
369(9; *)	370(3; *)	371(21; 0.5)	372(23; 0.5)	373(18; 0.5)
374(189; 9.5)	375(111; 2.7)	376(1; *)	379(20; *)	383(1; *)
384(13; *)	385(1; *)	386(1634; 15.9)	387(281; 3.2)	388(1203; 10.0)
389(42; 5.0)	390(23; 1.8)	391(12; 1.8)	392(16; 3.2)	393(17; 2.3)
394(10; 1.8)	395(5; *)	396(14; 2.3)	397(2; *)	399(122; 10.9)
400(213; 12.7)	401(56; 4.1)	402(113; 7.7)	403(36; 6.8)	405(6; 0.9)
429(3; 0.5)	430(17; 3.2)	431(1; *)	433(16; 4.1)	434(20; 5.4)
435(1; *)	436(377; 82.6)	437(3; 0.5)	438(4; 0.5)	440(6; 0.9)
443(4; 1.4)	445(3; 0.9)	447(1; 0.5)	455(2; 0.9)	459(13; 1.4)
463(1; *)	466(1; *)	471(1; *)	472(1; *)	473(1; *)
483(2; 0.5)	484(4; 0.5)	485(1; *)	486(3; 0.9)	487(2; 0.5)
488(1; *)	490(1; *)	493(17; 0.9)	494(2; *)	496(4; *)
497(1; *)	500(10; *)	501(1; 0.5)	509(18; 1.8)	510(3; 0.5)
511(13; 1.4)	515(1; *)	518(22; 1.4)	519(2; *)	522(1; *)
524(3; 0.5)	527(2; 0.5)	528(1; *)	529(1; 0.5)	542(15; 4.1)
543(18; 3.2)	544(1; *)	546(35; 2.7)	547(1; *)	556(10; *)
557(3; *)	558(3; *)	559(1; *)	560(2; *)	561(2; *)
564(6; *)	565(15; 0.9)	566(22; 1.4)	567(16; 0.9)	568(64; 4.5)
569(135; 13.6)	570(28; 1.8)	571(29; 4.1)	577(312; 23.6)	578(207; 17.2)
579(17; 0.9)	580(15; 1.8)	581(1; *)	583(2; 0.5)	589(4; 0.9)
590(24; 4.5)	591(1; *)	592(30; 1.8)	593(19; 2.3)	594(21; 3.6)

Table 3.--Continued

Alosa pseudoharengus--Cont.

598(1; *)	606(2; *)	608(6; 0.9)	615(1; *)	616(1; *)
618(1; *)	624(1; *)	625(1; *)	626(4; 0.5)	627(9; 1.4)
638(8; 0.9)	640(2; *)	641(2; *)	650(21; 1.8)	655(19; 1.4)
694(10; 1.8)				

Alosa sapidissima, American shad

2(1; *)	16(7; *)	17(6; 0.5)	28(1; *)	29(3; *)
53(16; 0.5)	54(4; 3.6)	256(1; *)	299(6; *)	300(6; *)
301(24; 0.5)	302(1; *)	306(10; *)	309(7; *)	310(3; *)
312(1; *)	314(2; *)	315(1; *)	316(1; *)	318(10; *)
319(23; *)	320(70; 1.8)	358(5; *)	359(2; *)	361(5; *)
363(15; *)	364(25; 0.5)	365(50; 0.5)	366(80; 0.9)	367(6; *)
368(6; *)	369(13; *)	371(4; *)	372(7; *)	373(2; *)
374(56; 0.9)	375(12; *)	379(1; *)	386(48; 0.9)	387(33; 0.5)
388(117; 1.4)	390(10; *)	393(3; *)	396(2; *)	399(3; 0.9)
400(3; 0.5)	401(5; 0.5)	402(3; *)	426(1; *)	436(11; 7.7)
440(7; 1.8)	511(2; *)	542(3; 1.8)	553(2; *)	554(1; *)
555(2; *)	556(8; *)	557(1; *)	558(2; *)	559(6; *)
560(1; *)	564(2; *)	566(2; *)	567(1; 0.5)	568(1; *)
570(4; 0.5)	571(1; *)	577(5; 0.5)	580(4; 0.5)	588(1; 0.5)
589(8; 0.9)	590(7; 0.9)	591(1; 0.9)	592(31; 0.9)	593(1; *)
611(3; 0.9)	612(1; 0.5)	619(1; 0.5)	625(1; *)	626(4; *)
638(6; 0.5)	641(1; *)	642(1; *)	650(1; *)	655(7; *)
694(1; 0.9)				

Brevoortia tyrannus, Atlantic menhaden

2(1; *)	3(1; *)	8(2; *)	9(4; 0.5)	10(1; *)
14(2; 0.5)	16(4; 0.5)	17(36; 7.3)	18(2; 0.5)	69(1; *)
237(2; *)	250(1; *)	256(15; 0.5)	258(1; *)	299(4; 0.9)
300(6; 0.5)	301(1; 0.5)	311(2; 0.5)	313(3; 0.5)	314(1; *)
315(3; *)	318(11; 3.2)	319(1; *)	320(2; *)	322(3; 0.9)
363(2; *)	364(1; *)	366(7; *)	369(2; *)	371(1; *)
372(5; 0.5)	373(1; *)	374(246; 1.4)	375(15; 0.5)	379(4; *)
381(1; *)	382(2; *)	386(27; 0.5)	387(2; *)	497(1; *)
549(4; 0.9)	550(1; *)	554(2; *)	555(1; *)	556(1; *)
628(1; *)	629(4; 0.9)	630(1; 1.4)	631(7; 0.9)	632(1; *)
633(2; *)				

Clupea harengus harengus, Atlantic herring

7(1; *)	14(4; 0.5)	17(70; 19.1)	358(5; 1.4)	359(3; 0.9)
362(3; 0.9)	364(10; 3.2)	365(1; 0.5)	366(3; 0.9)	369(1; 0.5)
370(1; 0.5)	371(1; 0.5)	373(2; 0.5)	374(2; 0.5)	375(24; 6.4)
376(2; 0.5)	377(1; 0.5)	379(1; *)	381(6; 1.4)	383(9; 2.7)
385(2; *)	387(8; 1.8)	388(15; 3.6)	399(2; 0.5)	400(4; 0.9)
401(1; *)	403(2; *)	461(1; *)	476(1; 0.5)	491(3; 0.9)
492(1; *)	493(1; 0.5)	495(1; *)	500(2; 0.5)	506(3; 0.5)
507(1; *)	509(3; 0.5)	513(5; 0.9)	518(2; 0.5)	546(1; *)
554(5; 0.9)	555(1; *)	568(1; *)	569(4; 1.4)	571(1; 0.5)
572(1; 0.5)	574(3; 0.5)	575(6; 1.4)	576(6; 1.8)	577(4; 0.9)
578(19; 5.0)	581(6; 1.8)	582(2; 0.5)	583(2; 0.5)	584(4; 1.4)
585(5; 1.4)	587(8; 2.3)	588(4; 0.9)	590(3; *)	591(3; 0.9)
599(2; 0.5)	618(4; 1.4)	619(2; 0.5)	631(1; *)	

e 3.--Continued

trumeus teres, round herring
84(1; *) 109(7; *) 111(11; *) 120(6; *) 137(2; *)
139(1484; 25.4) 140(140; 2.3) 142(1; *) 147(612; 10.9) 148(29; 0.5)
150(2070; 20.9) 151(23; 0.5) 169(33; 0.9) 171(1; *) 172(1; *)
176(644; 25.4) 181(3; *) 197(76; 1.4) 198(1682; 13.2) 199(204; 19.5)
209(1995; 25.9) 210(81; 1.4) 211(28; 0.5) 215(4; *) 216(2; *)
228(1060; 24.0) 229(1; *) 259(98; 1.8) 268(1; *) 269(12; *)
270(2187; 36.7) 276(2; *) 278(31; 0.5) 279(26; *) 297(2; *)
298(8; *) 324(1; *) 329(13; *) 357(1; *)

RAULIDAE

Anchoa hepsetus, striped anchovy
136(1; *) 322(3; *) 332(2; *) 333(10; *) 390(2; *) 566(2; *)
580(92; 0.5)

Anchoa mitchilli, bay anchovy
9(1; *) 11(1; *) 14(1; *) 16(104; 0.5)
17(2080; 9.1) 18(1152; 6.8) 61(792; 2.3) 67(1; *)
68(1; *) 73(2; *) 74(1; *) 75(7; *)
77(2; *) 78(164; 0.9) 79(840; 3.2) 92(1; *)
123(2; *) 124(35; *) 126(31; *) 128(67; 0.5)
130(17; *) 131(13; *) 133(1; *) 136(98; 0.5)
150(1; *) 182(152; 0.9) 183(29; *) 184(592; 2.3)
186(1; *) 187(192; 1.4) 188(980; 6.4) 189(1428; 4.1)
190(228; 1.4) 191(17; *) 192(144; *) 193(44; *)
194(1768; 7.7) 214(2; *) 215(10920; 33.6) 232(1; *)
239(4680; 1.4) 256(2046; 10.0) 258(15364; 20.9) 272(136; *)
273(184; *) 275(3; *) 298(5088; 10.9) 300(8; *)
302(26; *) 303(4; *) 307(1; *) 308(8; *)
309(22; *) 310(28; *) 313(4; *) 314(31; *)
315(20; *) 316(4; *) 317(2; *) 318(30; 0.5)
319(30; 0.5) 320(208; 0.5) 323(1; *) 325(3; *)
326(3; *) 358(1; *) 499(1; *) 570(890; 9.1)
581(9; *) 639(1; *) 641(1; *) 689(15; *)
700(1; *)

graulis eurystole, silver anchovy
125(2; *) 140(4; *) 147(369; 5.0) 148(1; *)
150(555; 6.8) 151(6; *) 195(152; 0.5) 196(30307; 41.7)
198(396; 4.1) 209(27; 0.5) 210(7752; 30.8) 211(5; *)
212(768; 1.8) 214(3; *) 237(312; 1.4) 238(504; 1.4)
240(280; *) 241(12; *) 245(480; *) 246(2; *)
247(16; *) 248(23; *) 249(50; *) 250(3; *)
251(64; *) 252(20; *) 253(10; *) 257(5200; 11.3)
259(2; *) 260(3; *) 270(344; 3.6) 565(1; *)
568(788; 2.3)

NTINIDAE

gentina silus, Atlantic argentine
36(1; *) 162(116; 0.9) 347(7; *) 348(9; *) 532(1; *)
538(1; *) 539(4; *) 604(7; *) 605(4; *) 613(3; *)
676(4; *) 677(1; *)

Table 3.--Continued

GONOSTOMATIDAE

Gonostoma elongatum, longtooth anglemouth (See: Leim and Scott 1966)
99(13; *) 289(2; *) 420(2; *) 458(2; *)

Maurolicus muelleri, Muller's pearlsides (See: Leim and Scott 1966)
163(2; *) 449(9; *) 538(1; *) 605(20; *)

CHAULIODONTIDAE

Chauliodus sloani, viperfish (See: Leim and Scott 1966)
99(1; *)

SYNODONTIDAE

Synodus foetens, inshore lizardfish
199(1; *) 208(3; *) 209(1; *) 215(4; *) 232(3; *) 238(1; *)
278(1; *) 294(1; *) 298(2; *) 329(1; *) 335(1; *) 352(1; *)
357(1; *)

Synodus sp.
268(1; *) 269(1; *) 275(1; *)

Trachinocephalus myops, snakefish
199(3; *) 212(8; *) 261(7; *) 262(2; *) 270(3; *) 272(1; *)
273(1; *)

CHLOROPHTHALMIDAE

Chlorophthalmus agassizi, shortnose greeneye
36(7; *) 39(3; *) 99(2; *) 163(7; *) 164(33; 0.5)
218(31; *) 221(126; 0.9) 286(2; *) 289(2; *) 420(7; *)
441(1; *) 449(1; *) 458(3; *) 531(9; *) 538(6; *)
539(1; *) 604(1; *) 605(3; *) 611(13; *) 669(1; *)
676(2; *) 677(7; *)

MYCTOPHIDAE

Myctophid, unidentifiable to genus

35(2; *) 36(1; *) 39(21; *) 99(2; *) 164(42; *)
218(152; 0.5) 221(128; *) 344(4; 0.5) 347(12; *) 420(4; *)
440(23; *) 441(10; *) 450(11; *) 451(20; *) 531(1; *)
537(1; *) 539(1; *) 613(1; *)

STERNOPTYCHIDAE

Argyropelecus aculeatus, Atlantic silver hatchfish (See: Leim and Scott 1966)
39(4; *) 100(4; *) 221(1; *) 289(3; *) 441(1; *) 458(1; *)

LOPHIDAE

Lophius americanus, goosefish
19(3; 23.1) 20(1; 3.2) 21(1; 2.7) 22(2; 7.7) 23(2; 5.4)
27(1; 10.0) 28(3; 24.5) 29(2; 12.7) 30(1; 1.8) 31(1; 12.2)
32(2; 1.8) 34(1; 0.9) 38(1; 6.4) 39(3; 8.2) 47(1; 3.6)
48(2; 11.8) 50(2; 11.3) 54(3; 14.5) 56(3; 8.6) 57(1; 0.5)
58(1; 3.6) 59(2; 0.9) 60(1; 0.5) 86(4; 4.1) 87(6; 15.0)
94(3; 4.1) 95(1; 12.7) 96(1; 0.9) 99(12; 28.1) 100(3; 4.1)
101(2; 2.3) 102(1; 8.2) 104(2; 1.8) 105(5; 1.4) 107(1; 1.4)
112(1; 7.7) 114(1; 5.0) 115(3; 2.3) 116(2; 9.1) 117(1; 0.5)

able 3.--Continued

Lophius americanus--Cont.

152(18; 36.3) 153(16; 27.2) 154(1; 1.4) 155(2; 1.8) 157(1; 5.0)
158(2; 0.9) 160(11; 36.7) 161(2; 7.7) 162(6; 20.0) 163(2; 0.9)
164(9; 0.5) 165(1; 3.6) 166(1; 1.8) 167(6; 5.4) 175(1; *)
178(1; 0.5) 210(1; 13.6) 215(1; 6.4) 217(8; 20.0) 218(1; 7.7)
219(1; 5.0) 220(2; 4.5) 221(8; 9.5) 222(1; 1.8) 223(3; 2.3)
224(7; 17.7) 225(4; 7.3) 226(6; 15.0) 227(1; 2.3) 228(16; 25.9)
231(1; 9.5) 259(1; 8.2) 260(2; 19.1) 261(1; *) 262(2; 23.1)
265(1; 7.3) 266(1; 4.1) 271(1; 14.5) 272(1; 11.8) 273(1; 4.5)
274(2; 18.6) 277(2; 19.1) 278(2; 16.3) 279(3; 25.4) 280(5; 4.1)
281(4; 10.4) 282(1; 1.8) 283(2; 6.8) 285(5; 13.2) 286(17; 29.0)
287(1; 5.0) 288(2; 2.3) 289(8; 5.9) 290(7; 2.7) 291(4; 6.8)
292(6; 17.7) 294(1; 7.7) 296(2; 1.4) 298(2; 16.3) 318(1; 10.4)
322(2; 21.8) 323(3; 34.9) 325(2; 21.3) 326(5; 30.4) 327(7; 76.7)
329(1; 7.7) 330(2; 15.9) 331(6; 38.1) 332(12; 100.2) 333(32; 243.6)
334(3; 14.5) 336(4; 15.0) 337(6; 8.6) 338(27; 39.5) 339(12; 22.7)
340(25; 44.9) 342(3; 9.5) 343(46; 50.8) 344(4; 5.0) 346(18; 24.5)
347(1; 0.5) 348(1; 0.9) 349(1; *) 350(1; *) 353(2; 10.9)
354(2; 29.0) 391(1; 14.1) 392(3; 31.3) 393(1; 0.9) 394(2; 8.6)
395(1; 1.4) 396(4; 9.1) 397(2; 13.6) 398(4; 13.2) 401(1; 12.2)
402(1; 9.1) 403(1; 10.9) 404(1; 4.5) 405(3; 18.1) 407(3; 5.0)
408(2; 7.7) 410(4; 8.2) 411(8; 5.9) 413(2; 2.3) 414(5; 9.5)
415(3; 7.3) 416(8; 15.4) 417(4; 9.5) 420(9; 6.8) 421(1; 0.9)
422(8; 10.4) 424(20; 37.6) 425(2; 2.7) 427(2; 11.8) 428(2; 13.2)
430(1; 9.1) 432(1; 6.8) 433(3; 9.5) 434(1; *) 437(8; 19.5)
440(2; 2.7) 441(2; 18.1) 442(5; 14.1) 443(1; 3.2) 444(1; 1.4)
445(2; 4.1) 446(3; 2.7) 447(4; 5.4) 448(1; 0.9) 450(1; 1.4)
452(1; 1.8) 453(1; 1.8) 455(2; 3.6) 458(10; 10.9) 467(1; 10.9)
478(1; 6.8) 504(2; 30.4) 505(1; 5.0) 507(1; *) 510(1; 9.1)
512(1; 3.2) 522(1; 5.9) 525(1; 2.7) 528(3; 3.2) 529(2; 3.6)
531(2; 6.4) 532(1; 2.3) 533(3; 4.5) 534(4; 5.4) 535(2; 3.2)
537(4; 11.3) 538(3; 18.1) 540(1; 1.4) 542(3; 4.5) 545(4; 15.4)
546(1; 1.8) 568(4; 31.8) 569(3; 24.0) 570(2; 6.4) 571(5; 26.3)
572(2; 10.9) 574(2; 6.4) 575(2; 1.4) 576(7; 18.1) 577(5; 48.1)
578(4; 30.8) 579(1; 10.4) 580(1; 10.9) 581(2; 15.4) 582(1; 3.2)
583(2; 1.8) 584(2; 16.8) 585(2; 9.5) 586(2; 4.5) 587(1; 1.4)
588(2; 19.5) 589(9; 100.7) 590(1; 14.1) 592(4; 44.9) 593(1; 8.6)
594(1; 11.3) 595(3; 4.5) 596(1; 0.9) 597(3; 6.8) 598(2; 5.0)
599(1; 2.3) 601(6; 23.6) 602(1; *) 603(10; 11.8) 604(4; 21.3)
605(5; 27.2) 606(3; 6.4) 607(1; 2.3) 608(4; 3.6) 609(6; 7.7)
611(1; 4.1) 612(8; 37.6) 613(1; *) 615(5; 10.4) 616(5; 8.2)
617(1; 3.2) 618(2; 2.7) 619(2; 2.3) 621(1; *) 622(1; 9.5)
623(4; 24.0) 624(1; 13.6) 625(2; 20.0) 626(2; 18.6) 638(1; 5.4)
640(1; 5.4) 641(4; 13.6) 642(1; 8.2) 643(7; 21.8) 644(2; 11.3)
645(3; 13.2) 646(3; 16.8) 647(2; 5.9) 648(2; 7.7) 649(2; 15.4)
650(6; 42.2) 651(5; 22.7) 652(5; 20.4) 653(2; 12.7) 654(1; 11.3)
655(2; 18.1) 657(3; 9.5) 658(1; 10.0) 659(1; 0.9) 660(2; 2.7)
661(2; 0.9) 662(1; *) 663(1; 0.5) 666(10; 26.8) 667(4; 8.6)
668(5; 8.6) 669(2; 5.4) 670(1; 10.0) 671(2; 1.8) 672(3; 1.4)
673(13; 33.6) 674(6; 13.2) 675(1; 4.1) 676(1; 0.5) 678(3; 6.4)
679(4; 11.3) 680(5; 10.4) 681(2; 2.7) 682(2; 13.6) 683(2; 14.1)
684(2; 10.0) 685(4; 20.4) 688(2; 8.2) 689(3; 18.6) 690(1; 5.0)
691(2; 8.6) 692(18; 2.7) 693(5; 35.4) 694(4; 34.0) 695(1; 7.3)
696(2; 10.4) 697(1; 5.4) 698(1; 7.7) 699(2; 8.2) 700(1; 15.4)

Table 3.--Continued

OGCOCEPHALIDAE

Dibranchus atlanticus, Atlantic batfish (See: Leim and Scott 1966)

99(7; *) 101(2; *) 164(4; *) 289(1; *) 290(1; *) 420(2; *)
458(1; *) 612(2; *)

GADIDAE

Enchelyopus cimbrius, fourbeard rockling

36(1; *) 163(2; *) 164(2; *) 175(1; *) 179(1; *) 228(1; *)
289(1; *) 296(9; 0.5) 346(1; *) 576(4; 0.5) 612(2; *) 667(1; *)
693(1; *)

Gadus morhua, Atlantic cod

324(3; 18.1) 327(2; 11.3) 330(1; 1.8) 331(2; 7.3) 334(1; 3.6)
337(1; 9.5) 341(5; 17.7) 352(7; 30.8) 353(2; 7.3) 354(2; 5.4)
356(5; 13.6) 390(2; 4.5) 391(3; 8.2) 392(8; 19.1) 393(4; 11.8)
394(2; 5.4) 395(2; 5.9) 396(7; 22.2) 397(9; 32.2) 398(3; 14.5)
399(1; 2.7) 400(1; 2.3) 401(9; 34.5) 402(9; 27.7) 403(6; 20.4)
404(3; 10.9) 405(4; 14.1) 406(1; 4.5) 425(1; 4.5) 426(1; 3.6)
427(2; 8.2) 430(3; 10.9) 431(3; 10.0) 432(2; 5.0) 433(2; 5.4)
434(5; 14.1) 435(1; 2.7) 436(1; 3.6) 437(1; 11.8) 443(1; 15.0)
445(1; 4.1) 446(2; 5.9) 459(2; 8.2) 460(4; 14.5) 461(1; 5.4)
462(2; 7.3) 463(1; 5.0) 464(2; 5.4) 474(3; 18.1) 475(1; 4.5)
476(1; 5.9) 477(1; 5.4) 479(4; 14.1) 480(3; 8.6) 481(1; 2.3)
482(1; 2.3) 484(13; 41.3) 485(1; 3.2) 502(4; 10.0) 503(1; 2.3)
504(1; 2.3) 506(4; 8.2) 507(1; 2.3) 508(4; 10.0) 510(4; 20.4)
511(2; 7.7) 512(8; 18.1) 515(39; 9.5) 519(1; 5.9) 521(2; 8.6)
522(1; 6.8) 525(4; 24.9) 527(1; 5.4) 546(4; 6.4) 572(2; 5.9)
585(1; 2.3) 586(1; 3.6) 587(10; *) 588(2; 5.0) 591(1; 6.8)
594(2; *) 595(1; 6.4) 598(1; *) 600(2; 10.0) 602(1; 4.5)
616(1; *) 623(1; 5.4) 652(2; *) 654(1; *) 655(1; 1.8)
659(2; *) 660(2; *) 661(2; *) 665(2; *) 687(2; *)

Melanogrammus aeglefinus, haddock

98(1; *) 591(1; *)

Merluccius albidus, offshore hake (See: Leim and Scott 1966)

36(2; *) 39(2; 0.5) 99(58; 23.6) 100(17; 2.3) 103(1; *)
163(81; 10.4) 164(85; 12.2) 167(42; 1.8) 218(14; 2.3) 219(32; *)
221(70; 10.9) 286(157; 39.5) 288(4; 0.9) 289(58; 10.9) 344(91; 23.1)
346(8; 3.2) 347(13; 0.9) 412(17; 2.7) 420(37; 10.0) 441(5; 4.1)
450(4; 0.9) 451(4; 0.9) 458(7; 1.4) 531(29; 12.2) 537(14; 3.2)
538(9; 2.7) 571(2; 0.9) 605(14; 5.0) 611(300; 53.1) 612(99; 39.9)
613(1; *) 669(22; 8.2) 672(1; 1.4) 676(9; 1.4) 677(1; *)

Merluccius bilinearis, silver hake

17(69; 3.2) 19(576; 12.2) 20(462; 9.5) 21(280; 6.4)
22(4; *) 24(25; 0.5) 28(397; 5.0) 29(754; 15.9)
30(2; 0.5) 31(7; 1.4) 32(8; 3.2) 34(2; 0.9)
36(2; *) 37(5; 0.9) 39(6; 1.4) 41(7; 1.8)
42(5; 0.5) 43(5; *) 44(6; *) 45(43; 0.5)
46(68; 1.4) 47(4; *) 48(79; 0.9) 49(19; 0.9)
50(2; *) 51(9; *) 52(41; 1.4) 53(76; 1.4)
54(15; 1.4) 55(14; *) 57(3; *) 58(30; 0.5)
59(4; 0.5) 60(17; 0.5) 80(11; 0.5) 83(2; *)

ble 3.--Continued

Merluccius bilinearis--Cont.

84(2; *)	87(16; 5.4)	90(3; *)	92(1; *)
93(1; *)	94(24; 3.6)	95(7; 0.5)	96(5; 0.5)
97(1; *)	98(11; 1.4)	104(2; 0.5)	105(5; 0.9)
106(3; *)	107(27; 1.4)	109(1; *)	111(1; *)
112(132; 6.4)	115(15; 0.9)	116(8; 0.5)	118(1; *)
119(11; 0.5)	120(14; 0.5)	141(9; *)	142(19;*)
143(1; *)	144(12; *)	145(10; *)	149(2; *)
150(1; *)	152(6; 0.5)	153(6; 0.5)	155(4; *)
157(31; 1.4)	158(4; 0.9)	159(2; 0.5)	160(19; 1.4)
161(16; *)	162(25; *)	166(1; 0.5)	168(2; *)
174(7; 0.5)	175(468; 20.4)	176(2; *)	178(2; *)
179(37; 1.4)	180(16; *)	197(2; *)	198(2; *)
200(2; *)	201(23; *)	202(15; *)	203(6; *)
204(27; *)	206(35; *)	207(1; *)	208(4; *)
209(98; 0.5)	210(1; *)	212(608; 1.8)	214(10; *)
215(243; 2.3)	216(1; *)	217(10; *)	223(3; 0.5)
224(7; 1.4)	225(5; *)	226(4; 0.9)	227(3; *)
228(1907; 110.7)	229(11; 0.5)	230(1; *)	232(1; *)
233(1; *)	234(33; 0.5)	259(44; 1.8)	260(219; 1.4)
261(21; *)	262(51; 0.5)	263(98; *)	264(21; *)
265(16; *)	266(2; *)	270(13; *)	271(52; *)
272(234; 1.4)	273(112; *)	274(184; *)	275(11; *)
276(6; *)	277(68; *)	278(3; *)	279(4; *)
280(4; 0.9)	281(1; *)	282(10; 1.4)	283(8; 1.8)
284(5; 0.5)	285(5; 0.5)	290(17; 0.9)	292(7; 3.2)
293(6; *)	294(3; *)	295(1; *)	296(8; 2.3)
297(2; *)	298(5; *)	299(14; *)	300(10; *)
301(2; *)	303(1; *)	305(2; *)	306(46; *)
308(8; *)	310(1; *)	311(1; *)	312(3; *)
316(10; *)	317(1; *)	318(27; *)	319(41; *)
320(5; *)	321(299; 1.4)	322(148; 1.8)	323(85; 1.4)
324(28; 0.9)	325(270; 2.3)	326(37; *)	327(58; 0.5)
329(11; 2.3)	330(130; 17.2)	331(257; 4.1)	332(28; 0.5)
333(29; 2.7)	334(28; 0.9)	335(2; 1.8)	337(1; *)
338(3; 0.5)	340(4; 0.9)	341(3; 0.9)	342(2; *)
349(2; 0.5)	350(1; *)	352(8; 1.4)	353(4; 0.9)
354(3; *)	356(5; 0.5)	359(1; *)	361(9; 0.5)
362(1; *)	371(2; *)	374(5; *)	379(1; *)
383(1; *)	386(15; 0.5)	387(28; *)	388(3; *)
389(34; 7.7)	390(34; 6.8)	391(58; 10.0)	392(80; 5.4)
393(77; 3.2)	394(99; 7.7)	395(55; 6.4)	396(95; 10.4)
397(42; 4.1)	398(71; 5.0)	399(136; 18.1)	400(125; 14.1)
401(198; 21.3)	402(138; 5.4)	403(72; 2.7)	404(79; 14.5)
405(42; 3.2)	406(182; 5.0)	407(4; 0.9)	408(1; 0.5)
409(9; 1.8)	410(15; 2.7)	411(6; 1.4)	413(18; 5.4)
414(7; 1.4)	415(36; 12.7)	416(18; 5.0)	417(17; 2.7)
420(3; *)	421(6; 1.8)	422(31; 7.3)	423(5; 2.3)
424(71; 19.1)	426(22; 3.2)	427(91; 3.6)	428(33; 3.6)
429(30; 4.5)	430(72; 10.0)	431(59; 8.6)	432(46; 12.7)
433(134; 10.0)	434(113; 11.3)	435(101; 13.2)	436(43; 14.5)
437(91; 19.5)	438(37; 9.5)	439(11; 2.7)	440(122; 29.5)
441(110; 29.5)	442(108; 20.0)	443(159; 15.0)	444(51; 7.7)
445(303; 54.9)	446(13; 1.8)	447(33; 10.9)	448(56; 14.1)
449(2; 0.5)	450(6; 1.4)	451(1; *)	452(85; 19.1)

Table 3.--Continued

Merluccius bilinearis--Cont.

453(79; 16.3)	454(277; 43.5)	455(177; 41.7)	456(100; 24.5)
457(33; 12.7)	458(9; 3.6)	459(44; 10.0)	460(127; 25.9)
461(5; 0.9)	462(1; *)	463(17; 2.3)	464(6; 2.7)
465(4; 0.5)	466(13; 3.6)	467(12; 2.3)	470(24; 6.4)
471(34; 10.0)	472(1; *)	473(6; 0.9)	474(16; 3.6)
475(6; 1.4)	476(2; 0.5)	477(3; 0.5)	478(1; *)
479(16; 2.3)	480(5; 2.7)	481(8; 0.9)	482(2; *)
483(5; *)	484(2; 0.5)	485(5; 0.9)	486(6; 1.8)
487(1; *)	488(1; *)	489(3; 0.9)	499(1; *)
501(26; 8.6)	502(21; 4.1)	503(43; 8.6)	504(37; 11.3)
505(19; 2.3)	506(17; 5.4)	507(13; 1.8)	508(7; 0.5)
509(2; 0.5)	510(1; *)	511(2; 0.9)	512(17; 0.5)
513(15; 2.3)	516(5; *)	517(2; 0.5)	518(7; 1.8)
519(1; 0.5)	521(17; 1.4)	522(55; 18.6)	523(7; 1.4)
524(3; 0.5)	525(3; 4.1)	526(2; 1.4)	527(36; 8.2)
528(8; 3.2)	529(4; 0.5)	530(2; 0.5)	531(26; 6.4)
533(2; 0.5)	534(1; *)	535(32; 18.1)	538(12; 2.3)
539(2; 0.5)	540(12; 3.2)	541(38; 8.2)	542(1; 1.8)
543(24; 6.4)	544(25; 7.7)	545(99; 34.9)	546(4; 0.9)
547(7; 7.7)	550(5; 1.4)	551(1; *)	555(1; *)
556(1; *)	557(6; 1.8)	558(33; 6.8)	559(4; *)
560(10; 2.7)	561(8; 2.3)	562(12; 3.2)	563(6; 2.3)
564(2; *)	565(7; 1.4)	566(17; 3.6)	567(121; 29.5)
568(14; 2.7)	569(28; 3.6)	570(187; 28.1)	571(93; 13.6)
572(16; 6.8)	573(7; 1.8)	574(6; 1.4)	575(5; 0.5)
576(14; 2.7)	577(10; 1.4)	578(16; 5.0)	579(29; 6.4)
580(41; 8.2)	581(328; 28.1)	582(169; 26.8)	583(168; 15.4)
584(31; 6.8)	585(21; 1.8)	586(4; 0.9)	587(12; 0.9)
588(53; 6.8)	589(153; 33.1)	590(190; 33.1)	591(24; 4.5)
592(59; 54.0)	593(334; 70.8)	594(175; 36.3)	595(58; 27.2)
596(6; 1.8)	597(10; 3.2)	598(10; 2.3)	599(16; 3.6)
600(37; 10.4)	601(21; 4.1)	602(16; 4.1)	603(23; 6.4)
604(13; 4.5)	605(81; 15.4)	606(6; 1.4)	607(5; 1.4)
608(16; 4.1)	609(17; 8.6)	610(21; 4.5)	613(6; 0.9)
614(7; 3.2)	615(21; 4.5)	616(36; 7.3)	618(8; 3.2)
619(35; 9.1)	620(10; 2.7)	621(34; 0.5)	622(36; 7.3)
623(11; 2.3)	624(3; 1.4)	625(23; 1.4)	626(69; 24.5)
627(3; 1.4)	638(2; *)	640(29; 0.5)	641(25; 1.8)
642(32; *)	643(2; *)	645(29; *)	646(5; *)
648(1; *)	649(36; 0.9)	650(26; *)	651(50; 0.9)
652(4; *)	653(179; 7.7)	654(6; 0.5)	655(23; 1.8)
656(5; 0.5)	657(3; 0.5)	659(21; 0.5)	660(2; *)
661(4; *)	663(5; 0.5)	664(5; 0.5)	665(5; 0.9)
666(2; 0.5)	667(4; 0.5)	668(4; 0.5)	669(5; 0.9)
670(4; 0.5)	671(30; 9.1)	672(16; 4.1)	673(5; 1.4)
674(9; 2.7)	675(1; 0.5)	678(6; 1.8)	679(12; 2.7)
680(11; 3.2)	681(8; 1.8)	682(5; 0.5)	683(3; *)
684(1; *)	685(62; 0.9)	686(26; 0.5)	687(59; 0.9)
688(14; *)	690(3; *)	691(10; 0.9)	692(18; 2.7)
693(22; 2.3)	694(57; 14.5)	695(3; *)	696(20; *)
697(7; *)	698(10; *)	699(11; 0.9)	700(2; *)

Microgadus tomcod, Atlantic tomcod

570(1; *)

3.--Continued

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hycis chesteri, longfin hake
39(3; *) 99(4; 0.5) 163(19; *) 164(50; 1.4) 221(1; *) 286(52; 5.0)
346(1; *) 417(4; *) 537(56; 2.3) 612(79; 5.0)

Physiculus fulvus, hakeling (See: Bigelow and Schroeder 1953)
163(2; *) 537(1; *)

Pollachius virens, pollock
415(1; 0.9) 444(1; 13.2) 529(1; 13.2) 659(1; *) 660(1; *) 665(3; *)

Urophycis chuss, red hake
14(1; *) 17(42; 2.3) 19(3; *) 21(5; *) 22(1; *)
28(2; *) 29(2; 0.5) 31(2; 0.5) 32(13; 4.1) 36(66; 5.4)
39(16; 4.5) 43(3; *) 44(3; *) 45(1; *) 46(3; *)
49(1; *) 54(7; 1.8) 58(13; 0.5) 59(2; 0.5) 60(11; *)
68(1; *) 71(1; *) 72(1; *) 77(2; *) 79(1; *)
80(1; *) 85(1; *) 87(180; 52.6) 90(7; *) 92(2; *)
93(20; *) 94(41; 6.4) 96(2; *) 99(128; 2.3) 100(13; 1.4)
104(19; 0.5) 105(756; 36.3) 106(4; 0.5) 107(64; 6.8) 111(6; *)
112(2; *) 113(2; *) 114(2; *) 117(5; *) 141(30; 1.4)
142(93; *) 143(6; *) 144(16; *) 145(72; *) 146(4; *)
150(2; *) 152(132; 14.5) 153(85; 9.5) 154(2; 0.5) 155(60; 8.6)
156(3; *) 157(7; 1.4) 159(4; *) 160(81; 7.7) 161(1; *)
163(42; 4.5) 164(5; 0.9) 167(176; 11.8) 168(4; *) 174(3; 0.5)
175(2; *) 176(34; *) 178(18; *) 179(35; *) 180(9; 0.5)
181(11; 0.9) 198(2; *) 199(1; *) 200(19; *) 201(2; *)
202(14; *) 203(3; *) 204(29; *) 205(2; *) 206(7; *)
211(2; *) 212(112; 0.5) 214(17; *) 215(9; *) 216(1; *)
217(1; *) 218(13; 0.9) 223(339; 37.6) 224(91; 6.4) 225(31; 5.0)
226(60; 5.0) 227(3; *) 228(141; 27.2) 229(4; 0.5) 233(20; *)
234(27; 0.5) 235(29; *) 236(10; *) 254(1; *) 260(18; *)
261(11; *) 262(42; *) 263(31; *) 264(13; *) 265(39; *)
266(4; *) 267(1; *) 268(1; *) 269(1; *) 270(1; *)
271(10; *) 272(65; 0.9) 273(74; 0.9) 274(20; *) 275(44; 0.5)
276(5; *) 277(25; *) 278(1; *) 279(1; *) 280(10; *)
281(20; *) 282(3; *) 283(1; *) 285(4; *) 289(15; 1.8)
292(1; *) 293(100; *) 294(11; *) 295(34; *) 296(18; 4.5)
299(1; *) 300(1; *) 302(2; *) 306(3; *) 310(1; *)
311(4; *) 318(4; *) 320(1; *) 321(30; *) 322(26; *)
323(34; *) 324(37; *) 325(163; 23.1) 326(1426; 20.9) 327(1482; 34.0)
329(1; *) 331(144; 2.7) 332(1038; 20.9) 333(1284; 27.2) 334(364; 9.5)
335(2; *) 336(1; 0.9) 338(15; 0.5) 339(5; *) 340(2; *)
341(7; *) 342(1; *) 344(96; 8.6) 346(362; 58.1) 347(5; 1.4)
348(45; *) 350(4; *) 351(1; *) 353(13; *) 354(7; 0.9)
356(23; 0.9) 357(2; 0.9) 361(8; *) 373(1; *) 375(1; *)
376(1; *) 386(6; 0.5) 387(7; *) 388(5; *) 389(61; 4.5)
390(35; *) 391(90; 3.2) 392(293; 2.3) 393(152; 1.4) 394(176; 3.6)
395(312; 3.6) 396(308; 10.0) 397(73; 0.5) 398(27; 0.5) 399(33; 1.8)
400(20; 0.5) 401(78; 1.4) 403(8; 0.5) 404(162; 1.4) 405(180; 3.2)
406(2; 0.9) 408(3; *) 409(1; 0.5) 410(51; 15.4) 412(1; 0.5)
413(8; 4.1) 414(10; 3.6) 415(68; 25.4) 416(22; 5.4) 417(6; 1.4)
420(56; 5.4) 422(64; 17.2) 424(348; 133.4) 426(7; *) 427(62; 0.5)
428(229; 15.4) 429(188; 12.7) 430(34; 0.9) 431(37; 3.2) 432(5; 1.8)
433(9; *) 434(1; 0.5) 435(33; 9.1) 436(12; 2.3) 437(141; 16.3)
438(54; 2.3) 439(47; 3.2) 440(5; 1.4) 441(135; 23.6) 442(31; 10.4)
443(1; *) 444(7; 3.2) 447(104; 27.7) 448(5; 2.3) 451(1; *)
452(32; 11.8) 453(29; 7.7) 454(1; 0.9) 455(18; 8.2) 456(10; 4.5)
458(34; 4.5) 459(4; *) 460(19; *) 461(110; 0.9) 462(48; 0.5)

Urophycis chuss--Cont.
463(47; 0.9) 464(19; *) 466(20; 1.4) 467(5; *) 470(27; 1.4)
471(12; 1.4) 473(1; *) 474(23; 2.7) 475(16; 1.4) 476(4; *)
477(22; 1.4) 478(12; *) 479(55; 0.9) 480(119; 1.4) 481(5; *)
482(2; *) 483(12; *) 484(33; 0.5) 485(1; *) 486(9; 0.5)
487(5; *) 489(1; *) 494(1; *) 501(85; 5.0) 502(50; 0.5)
503(116; 2.7) 504(105; 2.7) 505(93; 1.4) 506(12; *) 507(49; 0.5)
508(4; *) 509(2; *) 510(7; *) 511(42; 0.5) 512(7; *)
513(14; *) 515(38; 11.3) 517(20; 3.6) 518(31; 1.8) 521(58; 0.5)
522(102; 27.7) 523(52; 0.9) 525(11; 6.4) 526(3; 2.3) 528(7; 2.7)
529(3; 1.4) 530(3; 1.4) 531(8; 1.8) 534(2; 0.9) 535(60; 18.1)
540(2; 0.9) 541(11; 4.1) 542(7; 3.2) 543(4; 1.8) 544(40; 10.9)
545(7; 0.9) 546(5; *) 547(5; 1.8) 549(2; *) 550(3; *)
551(12; 1.4) 552(2; *) 555(4; *) 557(39; 1.8) 558(116; 7.7)
559(24; 0.9) 560(25; 1.8) 561(23; 5.0) 562(34; 5.4) 563(106; 13.2)
564(50; 5.0) 565(133; 9.1) 566(147; 9.1) 567(214; 25.4) 568(5; 1.4)
569(12; 0.5) 570(145; 31.3) 571(134; 20.9) 572(563; 7.7) 573(266; 8.2)
574(326; 5.4) 575(372; 37.6) 576(353; 23.1) 577(16; 0.9) 578(13; 4.5)
579(92; 9.5) 580(69; 12.2) 581(24; 1.4) 582(45; 4.1) 583(393; 8.6)
584(116; 3.2) 585(87; 1.8) 586(82; 9.5) 587(1; 0.9) 589(260; 27.7)
590(33; 0.5) 592(109; 15.4) 593(66; 8.6) 594(8; *) 595(97; 0.9)
596(14; *) 597(8; *) 599(1; *) 600(23; 0.5) 601(488; 184.2)
602(1; *) 603(125; 33.1) 604(6; 1.4) 605(18; 2.3) 608(6; 0.9)
609(6; 2.3) 613(30; 4.1) 614(4; 1.4) 615(48; 16.3) 616(56; 15.4)
618(2; 1.8) 619(308; 88.9) 620(4; 0.5) 621(113; 2.3) 622(83; 5.9)
623(66; 0.5) 624(13; *) 625(10; 0.5) 626(204; 50.8) 631(4; *)
636(21; *) 639(4; *) 640(12; *) 641(100; 3.6) 642(83; 2.3)
643(12; *) 644(5; *) 645(1; *) 649(2; *) 650(4; 0.5)
652(17; 0.5) 654(1; *) 656(5; *) 657(6; *) 658(23; 0.5)
659(10; *) 660(16; 0.5) 661(9; 1.8) 663(14; 0.9) 664(2; *)
665(5; 0.5) 666(41; 0.9) 667(17; 0.5) 668(5; 0.5) 669(33; 8.6)
671(91; 27.2) 672(145; 58.1) 673(79; 23.6) 674(224; 59.0) 679(140; 46.3)
680(33; 9.5) 681(15; 2.7) 684(1; *) 685(1; *) 686(7; 0.5)
687(41; 2.3) 688(36; 0.5) 689(39; 1.4) 690(3; *) 691(7; *)
692(106; 18.1) 693(41; 3.6) 694(66; 15.4) 695(7; 0.5) 696(4; *)
697(3; *) 698(5; *) 699(2; 0.5) 700(2; 0.9)

Urophycis regius, spotted hake
9(2; *) 17(3; *) 19(1; *) 28(7; *) 34(7; 2.3)
37(5; 0.9) 43(3; *) 44(21; *) 45(35; *) 46(576; 1.8)
47(5; *) 53(1; *) 77(1; *) 80(12; 0.5) 82(1; *)
83(8; 0.5) 84(55; 1.4) 85(37; 1.4) 86(5; *) 87(31; 0.9)
90(3; *) 92(12; 0.5) 93(10; 0.5) 94(5; *) 96(1; 0.5)
97(7; 0.9) 100(8; 2.3) 103(12; 0.9) 104(4; 0.5) 106(2; 0.9)
107(3; *) 111(1; *) 112(7; 0.9) 113(2; *) 114(17; 0.5)
115(540; 24.5) 116(492; 16.3) 117(47; 1.8) 118(1; *) 119(3; *)
120(30; 0.9) 139(2; *) 141(24; 1.4) 142(20; 1.4) 143(22; 1.4)
144(12; 0.9) 145(2; *) 146(3; 0.5) 149(1; *) 150(2; *)
152(1; *) 153(2; 0.5) 154(1; *) 155(6; *) 156(1; *)
158(9; 0.9) 159(1; 0.5) 160(14; 1.8) 161(7; 1.4) 166(28; 2.7)
167(4; *) 168(33; 1.4) 172(1; *) 174(5; 0.5) 175(3; *)
176(5; 0.5) 177(20; 1.4) 178(55; 2.7) 179(113; 5.0) 180(46; 1.8)
181(1; *) 199(5; 0.5) 200(10; 0.9) 201(19; 1.4) 202(4; *)
203(2; *) 204(2; *) 211(2; *) 212(17; 1.8) 213(1; *)
214(1; *) 215(8; 1.4) 217(53; 5.0) 225(1; *) 227(37; 4.1)

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ophycis regius--Cont.

228(11; 0.9) 229(2; *) 230(1; *) 233(8; 0.5) 235(6; 0.5)
236(107; 8.6) 260(14; 1.4) 261(3; 0.5) 262(8; 0.9) 263(9; 1.4)
264(8; 0.9) 265(3; *) 266(1; 0.5) 268(2; *) 271(3; 0.5)
272(10; 1.8) 273(3; 0.5) 274(7; 0.9) 275(6; 0.5) 276(10; 1.4)
277(7; 0.9) 280(3; *) 281(3; 0.5) 285(1; *) 288(3; *)
289(2; *) 290(54; 5.4) 291(6; 0.5) 293(3; *) 294(173; 0.5)
295(10; 0.9) 296(2; *) 303(1; *) 306(14; *) 307(2; *)
308(1; *) 309(6; *) 310(4; *) 312(23; *) 314(1; *)
316(20; *) 318(2; *) 319(1; *) 320(3; *) 322(25; *)
323(17; *) 324(4; 0.9) 325(24; 14.1) 326(17; 5.0) 327(7; 1.8)
329(1; *) 330(2; *) 337(7; 1.4) 338(4; 0.5) 341(2; 0.5)
343(1; *) 344(4; 0.5) 346(5; 1.4) 347(13; 2.3) 348(1; *)
349(1; *) 353(5; 0.9) 354(6; *) 356(3; 0.5) 357(11; 1.4)
361(2; *) 386(7; 0.5) 387(4; *) 390(10; *) 392(1; *)
393(1; *) 394(1; *) 395(2; *) 410(3; 0.5) 413(2; 1.4)
415(1; *) 416(1; *) 421(1; 0.5) 422(3; 0.5) 426(3; *)
449(3; 0.9) 462(1; *) 474(1; *) 486(1; *) 492(1; *)
521(2; *) 533(5; 1.8) 539(1; 0.5) 556(18; *) 558(1; *)
559(2; *) 604(13; 3.2) 605(2; *) 609(1; *) 610(7; 2.3)
614(1; 0.5) 624(2; *) 625(5; *) 626(1; *) 628(1; *)
629(3; *) 631(1; *) 638(1; *) 639(12; *) 640(1; *)
645(1; *) 660(1; *) 670(5; 1.8) 671(1; 0.5) 675(2; 0.9)
678(13; 3.2) 685(4; *) 687(2; *) 688(1; *) 689(2; *)
690(4; *) 692(1; *)

rophycis tenuis, white hake

156(3; 0.5) 157(35; 3.6) 286(5; 3.2) 296(1; *) 326(2; 1.8)
336(3; 0.9) 346(150; 40.4) 410(2; 3.2) 413(1; 0.5) 414(2; 3.2)
415(1; 8.6) 420(3; 1.8) 424(2; 2.3) 429(3; 0.9) 441(5; 8.2)
442(6; 2.7) 453(1; *) 458(2; 9.5) 531(1; 0.5) 535(1; 0.9)
537(1; 0.9) 577(2; 0.9) 605(4; 12.2) 606(4; 2.7) 607(2; 0.9)
611(10; 3.2) 612(3; 3.6) 626(2; 0.9) 628(2; *) 629(33; *)
630(20; *) 631(1; *) 669(3; 1.8) 687(1; *)

DIIDAE

epophidium cervinum, fawn cusk-eel

32(7; *) 33(11; *) 34(26; 0.5) 97(1; *) 98(4; *)
101(3; *) 104(4; *) 105(1; *) 158(1; *) 160(11; *)
161(90; 1.4) 162(124; 1.8) 167(5; *) 217(196; 3.2) 218(41; 0.9)
219(124; 0.9) 223(20; *) 274(1; *) 285(13; *) 290(5; *)
295(1; *) 322(1; *) 332(1; *) 338(4; *) 339(4; *)
340(18; 1.4) 343(2; *) 344(2; *) 347(6; *) 348(37; 0.5)
410(9; *) 416(2; *) 422(4; *) 449(27; 0.5) 450(32; 0.5)
451(8; *) 538(2; *) 540(1; *) 603(1; *) 605(3; *)
606(11; *) 607(3; *) 613(1; *) 615(5; *) 623(2; 0.5)
675(1; *) 689(1; *)

issola marginata, striped cusk-eel

144(3; 0.5) 212(5; *) 215(1; *) 233(1; *) 272(4; *) 283(1; *)
293(1; *) 325(1; *) 327(1; *) 334(2; *) 393(1; *) 410(1; *)
428(1; *) 430(1; *) 474(1; *) 521(1; *) 570(1; *)

Table 3.--Continued

ZOARCIDAE

Macrozoarces americanus, ocean pout
31(2; 0.9) 32(1; *) 51(1; 1.4) 57(1; 0.5) 58(1; *)
94(3; 0.5) 96(1; *) 105(4; 0.5) 107(25; 1.8) 112(6; 0.9)
152(5; *) 153(3; *) 154(1; *) 155(36; 4.1) 156(3; *)
157(7; 0.9) 158(1; *) 159(1; *) 167(4; *) 176(3; 0.5)
223(2; *) 224(5; 0.5) 225(2; *) 226(1; *) 227(2; *)
228(2; *) 229(53; 5.9) 230(1; *) 231(2; *) 236(1; 0.9)
281(2; *) 282(1; *) 291(1; *) 324(1; *) 336(7; 1.8)
337(2; *) 343(1; *) 389(2; 0.9) 391(1; *) 391(6; 1.8)
392(20; 6.8) 393(6; 3.2) 394(16; 5.4) 395(13; 6.8) 396(8; 5.0)
397(19; 12.7) 398(7; 7.3) 399(2; 1.4) 400(7; 6.4) 402(2; 1.4)
403(7; 5.0) 404(1; 0.9) 405(4; 4.5) 406(39; 30.8) 407(30; 17.2)
422(1; 0.5) 423(1; *) 427(5; 2.7) 429(2; 0.5) 430(3; 1.8)
431(6; 2.7) 433(1; 0.5) 434(4; 2.3) 435(45; 20.4) 436(15; 5.4)
437(51; 12.7) 438(4; 0.9) 439(5; 1.4) 443(6; 3.6) 444(1; *)
445(6; 5.0) 446(2; 2.3) 447(1; 0.5) 452(3; 2.3) 454(1; 0.5)
459(2; 1.4) 460(1; 0.5) 461(3; 0.5) 462(1; 0.9) 463(2; 1.8)
464(1; 0.5) 465(1; 0.5) 467(1; 0.5) 470(4; 1.8) 471(2; 1.4)
473(1; 0.5) 475(1; 0.5) 478(1; *) 479(8; 3.2) 480(1; 0.5)
483(2; 3.2) 484(1; 0.5) 485(1; 1.8) 501(34; 13.2) 502(6; 3.2)
503(1; 0.5) 504(1; *) 505(1; 0.5) 506(19; 16.3) 507(4; 4.5)
508(20; 25.9) 509(12; 13.2) 510(5; 5.4) 511(6; 5.0) 512(7; 10.9)
513(6; 6.4) 516(31; 32.2) 517(3; 1.4) 518(2; 0.9) 519(4; 2.7)
520(4; 2.3) 521(1; 0.5) 522(3; *) 523(1; *) 524(2; 2.3)
525(2; 2.3) 529(2; 1.8) 535(3; 1.8) 543(4; 4.1) 544(47; 8.6)
546(6; 4.1) 568(1; 0.5) 570(2; 0.5) 571(29; 14.5) 572(4; 2.7)
573(7; 2.7) 574(5; 2.7) 575(15; 10.9) 576(10; 4.1) 577(70; 52.6)
578(20; 17.7) 579(28; 12.2) 580(6; 2.3) 581(4; 1.8) 582(4; 2.7)
585(14; 11.3) 586(6; 5.9) 587(8; 7.3) 588(2; 1.4) 590(1; 1.8)
591(2; 1.4) 593(1; 0.9) 594(8; 7.3) 595(16; 16.8) 596(18; 17.2)
597(11; 8.2) 598(43; 37.2) 599(10; 9.1) 600(14; 14.1) 601(94; 50.8)
602(3; 1.4) 603(30; 15.9) 607(1; 0.9) 608(4; 3.2) 609(1; 1.4)
615(3; 2.3) 616(9; 5.0) 618(3; 1.4) 619(27; 10.0) 620(20; 12.7)
621(3; 1.4) 622(1; 0.9) 623(3; 3.2) 627(8; 9.1) 640(1; *)
642(1; *) 647(1; *) 654(1; *) 658(3; 0.9) 659(2; 0.5)
660(3; 0.9) 661(2; *) 665(2; *) 666(1; *) 667(1; *)
668(5; 1.8) 673(1; 0.5) 674(1; 0.9) 681(2; 0.5) 687(1; 0.5)
692(23; 8.2) 693(6; 0.9) 694(13; 3.6) 695(2; *) 696(1; *)
697(1; *) 699(5; 1.8)

Melanostigma atlanticum, Atlantic soft pout (See: Leim and Scott 1966)
221(4; *) 537(15; *) 538(1; *) 539(1; *)

MACROURIDAE

Coelorhynchus coelorhynchus carminatus, longnose grenadier (See: Marshall and Iwamot
164(3; *) 221(12; *) 286(5; *) 357(2; *) 458(1; *) 612(11; *)

Ventrifossa occidentalis, American straptail grenadier (See: Marshall and Iwamoto 19
458(1; *)

Nezumia bairdi, marlin-spike
99(11; 0.9) 163(3; *) 164(8; 0.5) 286(6; *) 346(1; *) 417(25; 0.5)
537(16; 0.9) 611(13; 0.9) 612(3; *)

e 3.--Continued

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acrourus berglax, roughhead grenadier (See: Marshall and Iwamoto 1973)
538(2; *) 612(14; *) 670(1; *)

rachyhynchus murrayi, roughnose grenadier (See Leim and Scott 1966)
670(1; *)

acrourid, unidentifiable to genus
289(3; *) 346(3; *) 531(6; *) 605(1; *) 669(3; 0.5)

OETIDAE
yporhamphus unifasciatus, halfbeak
226(1; *) 340(1; *)

RINIDAE
enidia menidia, Atlantic silverside
240(1; *) 250(6; *) 254(2; *) 256(1; *) 299(1; *)
301(24; *) 302(2; *) 303(7; *) 306(5; *) 307(1; *)
308(3; *) 309(2; *) 310(1; *) 312(1; *) 314(1; *)
316(1; *) 318(16; *) 319(7; *) 320(320; 1.8) 321(2; *)
325(1; *) 362(1; *) 364(3; *) 366(3; *) 387(2; *)
390(10; *) 391(8; *) 399(1; *) 402(7; *) 403(19; *)
474(1; *) 484(1; *) 509(2; *) 512(1; *) 517(1; *)
518(3; *) 519(3; *) 546(1; *) 549(1; *) 550(1; *)
553(28; *) 554(6; *) 555(12; *) 556(14; *) 560(1; *)
561(5; *) 562(1; *) 564(5; *) 628(78; *) 629(2; *)
633(12; *) 634(2; *) 635(9; *) 636(12; *)

MIXIIDAE
olymixia lowei, beardfish
164(1; *) 218(1; *) 344(4; *) 539(1; *) 677(1; *)

TEROSTEIDAE
asterosteus aculeatus, threespine stickleback
371(1; *) 511(1; *)

ULARIIDAE
istularia tabacaria, bluespotted cornetfish
172(1; *)

NATHIDAE
ippocampus erectus, lined seahorse
35(1; *) 150(1; *) 195(1; *) 197(1; *) 208(2; *)
209(1; *) 210(1; *) 212(1; *) 215(2; *) 250(1; *)
251(1; *) 255(1; *) 269(1; *) 270(1; *) 271(1; *)
272(4; *) 273(3; *) 274(1; *) 278(2; *) 279(2; *)
280(1; *) 293(1; *) 321(1; *) 322(1; *) 324(1; *)
327(193; 0.5) 330(2; *) 333(2; *) 334(1; *) 431(1; *)
432(2; *) 464(1; *) 484(3; *) 497(1; *) 512(1; *)
570(1; *)

yngnathus fuscus, northern pipefish
144(1; *) 145(1; *) 183(1; *) 212(1; *) 214(6; *)
215(1; *) 246(1; *) 256(8; *) 257(2; *) 258(2; *)
260(1; *) 264(1; *) 266(1; *) 270(1; *) 272(3; *)
273(1; *) 274(1; *) 312(1; *) 318(5; *) 320(10; *)

Table 3.--Continued

Syngnathus fuscus--Cont.
321(3; *) 323(2; *) 324(1; *) 325(22; *) 326(1248; 1.8)
327(7120; 10.4) 330(1; *) 331(1; *) 334(40; *) 394(2; *)
396(1; *) 398(1; *) 399(1; *) 400(2; *) 401(1; *)
427(2; *) 430(3; *) 431(3; *) 432(2; *) 434(1; *)
437(2; *) 460(6; *) 461(2; *) 462(2; *) 463(3; *)
464(2; *) 474(8; *) 478(1; *) 479(1; *) 480(8; *)
482(1; *) 483(1; *) 484(15; *) 486(1; *) 487(1; *)
503(3; *) 504(3; *) 505(3; *) 511(1; *) 558(1; *)
565(2; *) 566(3; *) 570(2; *) 598(1; *)

PERCICHTHYIDAE
Morone americana, white perch
300(1; *)

Morone saxatilis, striped bass
16(8; 17.2) 17(1; 2.7) 71(1; 0.9) 72(1; 0.9) 77(1; 1.8) 256(1; 1.4)
320(1; 5.4) 549(1; *) 568(2; 4.1) 580(1; 3.6)

SERRANIDAE
Centropristis striata, black sea bass
21(1; *) 23(1; 0.9) 36(1; *) 43(1; *) 48(1; 0.5)
51(1; 0.5) 82(1; *) 84(6; 1.8) 85(15; 5.9) 111(1; 0.5)
141(1; 0.5) 142(4; 0.9) 143(6; 1.8) 144(1; *) 147(19; 7.3)
171(1; 0.5) 172(1; 0.5) 186(4; *) 196(1; *) 197(1; *)
198(3; 0.5) 200(7; 3.2) 201(11; *) 204(6; 0.5) 205(11; *)
206(9; 1.4) 207(2; *) 212(15; *) 214(1; *) 215(5; 1.8)
232(1; *) 233(26; 0.5) 235(5; 0.5) 236(9; 3.6) 242(1; *)
259(1; *) 260(16; *) 261(4; 0.5) 262(2; *) 263(1; *)
264(3; *) 265(3; 0.5) 266(2; 0.5) 272(2; 0.5) 273(1; 0.5)
274(2; *) 276(2; *) 280(3; *) 281(5; *) 290(1; *)
293(127; 1.4) 294(14; 1.8) 295(46; 4.1) 297(1; *) 336(3; 1.8)
337(1; *) 338(2; *) 339(1; *) 340(2; *) 341(1; *)
342(2; *) 349(2; 1.8) 353(2; 0.9) 354(3; 0.9) 413(6; 0.9)
416(4; *) 422(6; *) 429(1; *) 484(1; *) 519(1; *)
574(1; 0.9) 577(3; 0.9) 578(2; 1.4) 579(2; 0.5) 580(1; *)
584(1; *) 585(1; *) 587(1; 0.5) 588(1; 0.5) 589(1; 0.9)
590(3; 1.8) 592(2; 2.7) 593(7; 5.4) 594(1; *) 606(1; *)
608(1; *) 619(2; 0.5) 620(1; 0.9) 621(1; *) 622(3; 0.9)
623(2; 0.5) 624(2; 0.5) 625(3; 1.4) 626(1; 0.5) 627(1; 1.4)
629(1; *) 638(17; 3.6) 640(8; 1.8) 641(1; *) 642(1; *)
643(7; 2.3) 644(12; 2.7) 647(1; *) 649(1; 0.5) 650(1; 0.5)
651(1; 0.5) 661(1; *) 662(1; *) 665(1; *) 683(1; *)
684(2; *) 685(27; 4.1) 686(2; *) 687(7; 1.8) 688(4; 0.9)
689(19; 2.7) 690(9; 2.3) 691(8; 2.3) 692(1; *) 693(2; *)
694(6; 1.4) 697(2; 0.5) 698(1; *) 699(5; 1.8) 700(3; *)

PRIACANTHIDAE
Priacanthus arenatus, bigeye
293(1; *)

Pristigenys alta, short bigeye
90(1; *)

.e 3.--Continued

GONIDAE

Apogon pseudomaculatus, twospot cardinalfish

100(1; *) 221(78; 0.9) 289(1; *)

Apogon sp.

611(1; *) 677(1; *)

NCHIOSTEGIDAE

Lopholatilus chamaeleonticeps, tilefish

37(2; 0.5) 40(1; 6.4) 222(1; *) 287(2; 2.7) 347(1; *) 348(1; 1.8)
451(1; *) 536(1; *) 613(1; 3.2) 675(1; *) 678(4; 0.5)

ATOMIDAE

Pomatomus saltatrix, bluefish

1(1; 2.3) 16(2; *) 17(3; *) 18(2; 5.0) 25(1; 2.7)
29(1; 1.4) 47(1; 3.2) 48(6; *) 53(2; *) 54(1; *)
64(1; *) 65(1; *) 66(2; 0.5) 67(10; 4.1) 68(6; 3.6)
74(1; *) 77(1; 5.0) 78(10; 2.3) 79(2; 0.5) 83(1; 3.2)
90(3; *) 118(1; 1.8) 124(2; *) 130(1; 0.5) 133(1; 0.9)
134(1; 0.5) 136(6; 0.5) 139(1; 0.5) 147(4; 11.3) 149(1; 4.5)
150(101; 2.7) 151(3; *) 182(13; 1.4) 185(2; *) 187(2; *)
189(1; 3.6) 191(1; 0.5) 192(2; *) 193(4; 0.5) 194(24; 1.4)
195(42; 5.9) 210(43; 7.7) 211(3; 0.5) 215(2; 0.9) 232(14; 10.0)
237(8; 0.5) 238(4; 0.5) 239(1; *) 240(1; *) 256(85; 6.4)
257(12; 4.1) 259(11; 13.2) 260(2; 8.2) 262(11; 0.9) 263(1; *)
266(1; 5.0) 267(3; 18.6) 268(1; 2.3) 271(1; 2.7) 272(1; *)
274(1; 3.6) 278(14; 0.9) 279(2; 9.1) 284(1; 5.4) 295(1; 4.5)
298(40; 2.3) 303(1; 4.5) 320(1; 3.6) 322(65; 5.0) 323(4; *)
331(1; 3.6) 340(1; 2.3) 352(5; 29.9) 648(3; *) 687(1; 1.8)

ANGIDAE

Decapterus macarellus, mackerel scad

207(1; *)

Decapterus punctatus, round scad

89(1; *) 90(5; *) 92(2; *) 138(1; *) 140(72; 0.5)
148(101; 0.9) 149(1; *) 150(5; *) 197(32; 0.5) 198(1; *)
199(1; *) 208(10; *) 209(2; *) 266(1; *) 267(1; *)
268(1; *) 297(17; *)

Naucrates ductor, pilotfish

164(1; *)

Selar crumenophthalmus, bigeye scad

111(5; *) 120(2; *) 148(1; *)

Seriola zonata, banded rudderfish

39(1; *) 138(4; 0.5) 160(1; *)

Trachurus lathami, rough scad

120(1; *) 267(2; *) 280(3; *) 294(1; *)

Vomer setapinnis, Atlantic moonfish

182(2; *) 187(1; *) 193(1; *) 194(1; *) 195(1; *) 210(10; *)
232(1; *) 237(1; *) 298(1; *)

Table 3.--Continued

LUTJANIDAE

Lutjanus sp.

212(1; *)   297(1; *)

POMADASYIDAE

Orthopristis chrysoptera, pigfish

242(1; *)   325(2; *)

SPARIDAE

Lagodon rhomboides, pinfish

266(1; *)   277(1; *)   323(1; *)   327(1; *)

Stenotomus chrysops, scup

1(1; *)   3(1; *)   10(1; *)   16(1; *)   19(120; 3.6)
20(5; *)   21(22; 0.5)   22(1; *)   23(57; 1.8)   24(78; 2.7)
28(5; *)   29(7; *)   31(1; *)   45(6; *)   46(11; *)
49(1; *)   50(1; *)   52(68; 2.7)   53(28; 1.4)   58(2; *)
61(3; *)   62(1; *)   63(15; 0.9)   68(1; *)   79(1; *)
81(50; 1.8)   82(3; 0.5)   84(3; *)   85(2; *)   118(2; *)
137(1; *)   139(2; *)   140(19; 0.9)   141(9; 0.9)   143(63; 0.9)
144(37; *)   147(9; 0.5)   148(2; *)   150(2; 0.5)   184(2; *)
186(76; 0.5)   188(1; *)   189(1; *)   193(1; *)   196(4; 0.5)
197(120; 7.3)   198(87; 1.4)   199(170; 14.1)   200(1; *)   202(41; 1.8)
203(1; *)   204(10; 0.9)   205(6; *)   206(201; 8.2)   208(104; 0.5)
209(2; *)   210(7; 0.9)   211(8; 0.5)   212(29; 0.5)   213(1; *)
214(184; 0.9)   215(20; 2.7)   216(21; 1.8)   217(3; 0.5)   226(1; *)
227(6; 0.5)   228(3; 0.5)   231(25; 2.3)   232(2; *)   233(19; 0.9)
234(138; 0.5)   235(1; *)   236(24; 2.3)   242(1; *)   259(454; 31.8)
260(24; 1.4)   261(16; *)   262(1; *)   263(5; *)   264(8; 0.9)
265(137; 5.4)   266(607; 51.3)   267(315; 6.4)   268(763; 16.8)   269(12; 1.4)
271(8; 0.5)   272(1; *)   273(22; 0.5)   274(280; 6.4)   275(1; *)
276(1566; 24.5)   277(350; 9.5)   278(9; *)   279(29; 0.5)   280(180; 10.4)
281(29; 5.4)   282(18; 4.5)   283(23; 6.8)   284(12; 4.1)   291(11; 2.3)
292(4; 0.9)   293(68; 3.6)   294(5; *)   295(288; 5.0)   297(2245; 20.4)
298(3; *)   299(42; *)   321(1; *)   324(1; *)   328(46; 5.0)
329(25; 4.5)   330(82; 26.3)   335(23; 1.8)   336(14; 4.1)   337(102; 25.9)
338(7; 2.3)   339(9; 2.3)   340(35; 24.9)   342(90; 3.6)   343(221; 26.8)
349(117; 68.5)   350(66; 7.7)   351(12; 1.4)   352(1; *)   353(12; 2.3)
354(26; 1.4)   357(4; 0.9)   410(1; *)   413(1; *)   422(1; *)
533(1; *)   540(2; 0.5)   568(1; 0.5)   569(2; 0.5)   571(9; 4.1)
572(1; *)   574(1; *)   575(1; *)   577(23; 4.1)   573(17; 6.4)
579(13; 3.6)   580(3; 0.5)   581(5; 0.5)   583(25; 3.6)   584(18; 2.7)
585(31; 5.0)   586(2; 0.5)   587(3; 0.5)   588(168; 47.2)   590(267; 35.8)
591(5; 0.9)   592(20; 3.2)   593(64; 12.2)   594(53; 8.2)   597(2; 0.9)
598(1; *)   599(3; 0.5)   600(5; 0.9)   601(4; 0.9)   602(1; 0.5)
603(38; 11.3)   607(2; 0.5)   608(1; *)   609(7; 1.8)   618(1; *)
619(1; *)   620(7; 1.4)   621(1; *)   622(4; *)   623(3; *)
624(35; 0.9)   625(5; *)   626(2; *)   627(2; *)   628(1; *)
634(2; *)   635(1; *)   637(41; 0.9)   638(34; 0.9)   639(16; 0.5)
640(9; *)   641(6; *)   642(11; *)   643(12; *)   644(195; 4.1)
645(287; 6.4)   646(23; 0.9)   649(17; 0.5)   650(360; 9.1)   651(4; *)
653(13; 0.5)   654(1; *)   655(47; 1.4)   656(1; *)   659(2; *)
660(1; *)   665(2; *)   668(2; *)   672(1; *)   673(2; *)
674(3; *)   684(17; 0.5)   685(25; 0.5)   687(3; *)   688(3; *)
689(4; *)   690(5; *)   691(2; *)   692(2; *)   693(5; *)
695(1; *)   697(2; *)   699(3; *)   700(24; 0.5)

3.--Continued

ENIDAE

irdiella chrysura, silver perch

237(1; *)   242(5; *)   246(1; *)   256(4; 0.5)   318(3; *)   325(3; *)

ynoscion regalis, weakfish

1(1; 2.3)   63(1; 0.9)   65(3; 3.2)   66(5; 18.6)   67(2; 4.1)
68(6; 6.4)   69(1; *)   70(2; 4.1)   76(1; 2.7)   77(11; 42.2)
78(7; 17.7)   79(3; 14.5)   115(4; 9.5)   116(1; 2.7)   123(1; *)
124(1; *)   126(1; *)   131(1; 1.4)   132(4; 8.6)   134(1; 1.4)
136(5; 5.9)   150(1; *)   182(18; *)   184(5; *)   185(9; 5.9)
187(100; 1.4)   188(1; *)   189(6; *)   190(2; *)   192(29; 0.5)
193(13; 2.3)   194(56; 0.5)   195(295; 3.2)   196(13; *)   209(2; *)
210(61; 3.2)   212(47; 6.8)   213(1; 1.8)   214(1; 1.8)   215(76; 3.2)
232(1; *)   233(1; 2.3)   237(6; *)   238(6; *)   239(1; *)
241(1; *)   242(59; 1.4)   243(1; *)   244(2; *)   245(3; *)
246(1; *)   247(2; *)   256(42; 0.5)   257(11; *)   263(1; 2.3)
266(2; 5.4)   272(29; 3.6)   275(3; 3.6)   276(1; 1.8)   298(27; 0.9)
299(10; *)   301(1; *)   302(2; *)   306(4; *)   309(1; *)
310(3; *)   311(7; *)   316(5; *)   318(72; 0.5)   319(19; 2.3)
320(3; *)   323(18; 0.5)   324(1; *)   325(306; 5.0)   326(145; 4.5)
327(580; 25.4)   332(84; 5.0)   332(512; 16.8)   334(40; 3.2)   340(1; 3.2)
568(2; *)

eiostomus xanthurus, spot

182(1; *)   192(1; *)   194(5; 0.5)   195(8; 0.9)   210(1; *)   232(1; *)
242(3; *)   256(2; *)   319(1; *)

enticirrhus saxatilis, northern kingfish

184(1; *)   186(1; *)   187(1; *)   190(3; *)   191(9; 0.5)   196(6; *)
199(1; *)   208(1; *)   210(1; *)   232(1; *)   234(1; *)   254(1; *)
262(2; 0.5)   263(3; 0.5)   271(8; 1.4)   272(19; 4.1)   273(6; 0.9)   275(5; *)
276(1; *)   278(1; *)   298(12; 0.9)   322(6; *)   325(14; *)   326(1; *)
329(1; *)   331(2; *)   332(2; *)   333(1; *)   357(1; *)

icropogon undulatus, Atlantic croaker

195(1; *)   233(2; 0.9)   242(1; *)   325(2; *)

IDAE

ullus auratus, red goatfish

90(2; *)   111(1; *)   140(1; *)

ETODONTIDAE

Chaetodon ocellatus, spotfin butterflyfish

184(1; *)   322(1; *)

RIDAE

Tautoga onitis, tautog

7(1; 1.4)   17(1; 3.2)   70(1; *)   124(1; *)   134(1; 1.4)   240(1; 0.5)
255(12; 4.5)   257(1; *)   258(2; 1.8)   259(9; 19.5)   270(1; 0.5)   272(1; 0.5)
278(1; 0.5)   304(2; 0.9)   307(1; *)   310(1; *)   325(7; 0.5)   327(1; *)
388(2; 0.5)   389(1; *)   437(1; *)   470(2; 1.4)   522(1; 0.5)   554(1; 0.9)
556(2; 0.5)   560(1; 2.3)   561(3; 1.4)   565(3; 3.2)   567(9; 11.8)   568(2; 1.4)
569(1; 1.4)   639(1; 0.9)

Table 3.--Continued

Tautogolabrus adspersus, cunner
21(1; *) 50(2; 0.5) 51(1; *) 52(2; *) 53(2; *)
54(16; 2.3) 85(2; *) 120(6; 0.9) 174(1; *) 198(1; 0.5)
206(2; *) 231(1; *) 236(4; *) 241(1; *) 259(92; 14.5)
274(1; *) 304(20; 1.4) 322(1; *) 324(1; *) 334(4; *)
389(592; 34.5) 390(1; *) 437(20; 3.6) 439(43; 3.6) 480(1; *)
501(1; 0.5) 522(18; 1.8) 529(8; 5.0) 544(1; 0.5) 547(16; 1.4)
568(75; 12.7) 569(2; *) 571(2; *) 572(2; *) 575(2; *)
577(31; 5.4) 581(1; *) 594(1; *) 626(2; *) 638(8; 1.4)
640(3; *) 690(1; *) 692(5; 0.9) 697(3; 0.5) 699(11; 0.5)

MUGILIDAE
Mugil curema, white mullet
192(1; *)

SPHYRAENIDAE
Sphyraena borealis, northern sennet
198(1; *) 259(1; *) 261(1; *) 330(3; *)

URANOSCOPIDAE
Astroscopus guttatus, northern stargazer
238(1; *) 242(1; *) 249(1; *) 257(1; *) 258(1; *)

BLENNIIDAE
unidentifiable to genus
522(1; *)

PHOLIDAE
Pholis gunnellus, rock gunnel
105(2; *) 107(1; *) 167(1; *) 196(2; *) 258(4; *) 320(2; *)
336(1; *) 338(1; *) 388(2; *) 566(1; *) 567(4; *) 617(1; *)

AMMODYTIDAE
Ammodytes americanus, American sand lance
28(1; *) 50(1; *) 51(1; *) 53(1; *)
94(2; *) 106(1; *) 110(1019; 21.3) 146(1; *)
156(520; 11.8) 205(1; *) 215(1; *) 231(19874; 536.6)
232(21; 0.5) 236(1; *) 251(15; *) 254(1; *)
273(1; *) 294(2; *) 303(1; *) 325(3; *)
352(2; *) 360(22; *) 362(21; *) 376(29; *)
377(16; *) 378(1; *) 391(1; *) 392(1; *)
393(2; *) 402(4; *) 405(2; *) 426(4; *)
427(5; *) 428(8; *) 429(1; *) 430(2; *)
432(56; 0.9) 433(1; *) 437(1; *) 463(1; *)
474(6; *) 476(2; *) 477(3; *) 509(2; *)
518(2; *) 520(354; 6.4) 521(24; 0.5) 545(56; *)
546(2; *) 547(1; *) 568(22; 0.5) 579(8; *)
591(1; *) 620(1; *) 624(5; *) 625(2; *)
637(53; *) 648(2; *) 650(1; *) 662(304; 10.0)
682(2; *) 687(1; *) 699(2; *)

TRICHIURIDAE
Trichiurus lepturus, Atlantic cutlassfish
420(1; *)

3.--Continued

IDAE

umber scombrus, Atlantic mackerel

18(1; *) 33(14; 0.9) 36(1; 0.5) 92(16; 0.5) 101(2; *)
164(3; *) 199(1; *) 212(1; *) 282(1; *) 352(1; *)
392(1; 0.5) 410(19; 0.9) 414(46; 2.7) 415(1; *) 422(1; *)
440(102; 34.0) 441(16; 6.4) 447(1; 0.5) 448(1; 0.5) 450(14; 1.8)
451(4; 0.5) 454(2; 0.9) 457(1; *) 515(2; *) 536(2; 0.5)
568(1; 0.5) 569(5; 0.5) 578(1; *) 584(2; *) 586(1; *)
587(16; 2.3) 591(1; 0.5) 597(2; *) 601(1; *) 608(1; 0.5)
615(1; *) 618(5; 1.4) 619(1; *)

MATEIDAE

riomma bondi, silver-rag

91(1; *) 151(1; *)

eprilus triacanthus, butterfish

1(2; *) 2(46; 1.8) 3(4; *) 9(10; 0.5)
16(9; 0.5) 17(37; 1.4) 18(2; *) 19(4; 0.5)
21(3; *) 22(1; *) 23(9; 0.5) 24(23; 0.9)
27(34; 1.8) 28(8; 0.5) 29(164; 7.3) 30(138; 10.0)
33(25; 1.4) 34(3; *) 36(5; *) 37(8; 0.9)
38(766; 103.9) 44(2; *) 45(1; *) 46(5; *)
47(5; *) 48(246; 19.5) 49(1; *) 50(353; 20.0)
51(4; *) 52(7; *) 53(38; 3.2) 54(4; 0.5)
61(16; 0.9) 73(1; *) 78(4; *) 79(3; *)
80(238; 3.6) 81(182; 1.8) 82(434; 9.5) 83(37; 0.5)
84(6; 0.5) 87(9; 0.9) 88(106; 1.4) 89(51; 0.9)
90(5120; 3.6) 91(1360; 9.1) 92(17820; 20.4) 96(1; *)
97(11; 1.4) 98(95; 8.6) 101(22; 1.8) 107(35; 1.4)
108(54; 0.9) 109(776; 1.8) 110(184; 2.3) 111(1012; 3.2)
112(1123; 26.8) 113(6; 0.5) 117(1; *) 118(980; 6.4)
119(106; 5.4) 120(1032; 7.3) 123(2; *) 125(1; *)
126(1; *) 128(4; *) 131(2; *) 136(3; 0.5)
137(208; *) 138(388; 0.5) 139(8432; 7.7) 140(1602; 11.3)
143(16; *) 144(344; 0.5) 146(4; *) 147(98; 2.3)
148(29; 0.5) 149(17; 0.5) 150(368; 0.9) 151(3; *)
152(1; *) 154(4; 0.5) 155(25; 2.7) 156(68; 2.7)
157(110; 5.4) 158(2; *) 161(738; 59.9) 163(1; *)
166(1776; 103.4) 167(10; 0.9) 168(4; *) 169(221; 4.1)
170(22; 0.5) 171(78; 1.4) 172(30; 0.5) 173(105; 1.4)
174(2600; 63.5) 175(1233; 47.2) 176(910; 35.4) 177(80; 2.7)
178(279; 1.4) 179(56; 0.5) 180(13; *) 182(14; 0.5)
183(7; *) 185(1; *) 189(1; *) 190(2; *)
191(3; *) 192(3; *) 193(3; *) 194(8; 0.5)
195(27; 0.9) 197(590; 4.5) 198(1200; 5.4) 199(240; 0.9)
202(1; *) 203(4; *) 204(5; *) 205(1; *)
206(3; *) 207(1; *) 208(14220; 35.8) 209(552; 1.4)
210(27; 0.5) 211(1463; 8.6) 212(59; *) 214(26 *)
215(462; 5.9) 216(92; 0.9) 217(186; 13.6) 220(37; 1.8)
222(87; 3.6) 224(2; *) 225(1; *) 226(2; *)
228(34; 1.4) 229(2; *) 230(5; *) 232(297; 4.1)
233(1; *) 235(5; *) 237(20; 1.8) 238(11; 0.5)
239(29; 1.4) 240(2; *) 244(4; 0.5) 249(2; *)
256(62; 3.2) 257(12; 0.5) 258(7; 0.5) 259(203; 29.5)
260(3; *) 262(9; *) 263(67; 0.9) 264(2; *)

Table 3.--Continued

Peprilus triacanthus--Cont.

265(3; *) 266(427; 6.4) 267(558; 9.5) 268(2455; 33.6)
269(3368; 18.1) 270(13; *) 271(270; 5.4) 272(14; *)
273(14; *) 274(102; 0.5) 275(3; *) 276(123; 0.9)
278(184; 0.9) 279(340; 1.8) 280(1; *) 281(1; *)
284(14; 1.4) 288(66; 5.9) 289(6; 0.5) 290(1210; 73.0)
292(13; 1.4) 294(2; *) 297(203; 5.0) 298(504; 5.4)
302(2; *) 311(1; *) 318(1; *) 319(1; *)
321(8; *) 322(72; 4.1) 323(8; 0.9) 324(1; *)
329(53; 2.7) 330(8; 0.9) 335(1; *) 337(16; 1.8)
338(4; *) 349(3; *) 352(55; 0.5) 353(3; 0.5)
356(1; *) 410(5; 0.5) 413(36; 0.9) 414(2; *)
416(15; *) 422(4; *) 424(2; 0.5) 441(1; *)
442(102; 3.2) 444(1; *) 446(1; 0.5) 448(1; *)
449(40; 2.3) 450(3; 0.5) 451(2; *) 452(5; 0.9)
453(4; 0.9) 455(2; 0.5) 456(1; *) 458(1; *)
522(1; *) 532(38; 1.4) 533(17; 0.9) 534(23; 1.8)
536(58; 3.6) 540(5; 0.9) 542(7; 1.4) 556(2; *)
567(1; *) 568(24; 2.7) 570(12; 1.4) 573(2; *)
577(4; 0.5) 578(1; *) 579(1; *) 580(19; 1.4)
583(1; *) 584(4; 0.5) 585(5; 0.5) 587(8; 0.9)
588(6; 0.5) 589(9; 1.4) 590(9; 1.4) 591(1; *)
592(8; 1.4) 594(2; *) 603(13; 0.9) 604(7; 0.9)
605(43; 5.4) 608(3; 0.5) 609(1; *) 610(39; 1.8)
611(3; *) 613(19; 1.8) 615(1; *) 617(2; 0.5)
620(1; *) 623(1; *) 626(1; *) 628(8; 0.5)
630(10; 0.5) 631(3; *) 633(3; *) 636(2; *)
638(358; 38.6) 639(39; 3.2) 645(6; *) 650(84; 6.4)
651(5; 0.5) 654(1; *) 655(42; 2.7) 659(1; *)
660(1; *) 670(120; 6.4) 671(267; 29.5) 672(16; 1.8)
675(64; 3.2) 677(1; *) 678(22; 1.4) 679(2; 0.5)
685(22; 0.9) 686(1; *) 691(1; *) 692(3; *)
693(1; *) 694(4; *) 695(2; *) 700(36; 4.1)

SCORPAENIDAE

Helicolenus dactylopterus, blackbelly rosefish

33(16; *) 34(1; *) 36(93; 0.5) 38(17; *) 39(65; 2.7) 40(6; *)
99(36; 1.4) 100(29; 0.9) 101(25; *) 102(15; *) 162(61; *) 163(26; 0.5)
218(2; *) 219(4; *) 221(78; 0.9) 286(93; 4.1) 289(7; 0.5) 290(2; *)
344(6; *) 347(7; *) 420(9; 0.5) 440(1; *) 449(1; *) 450(19; *)
451(6; *) 458(31; 2.7) 531(47; *) 533(1; *) 538(32; 0.5) 539(13; *)
604(2; *) 605(4; *) 610(2; *) 611(17; 0.5) 612(58; 2.3) 613(1; *)
669(58; 3.2) 670(4; *) 675(9; *) 676(5; *) 677(20; *)

Scorpaena plumieri, spotted scorpionfish

38(1; *)

Sebastes marinus, ocean perch

605(2; *) 610(1; *) 670(2; *) 692(1; *)

TRIGLIDAE

Peristedion miniatum, armored searobin

102(2; *) 162(8; 0.9) 164(1; *) 218(9; 0.5) 219(3; *)
222(18; 4.1) 223(4; 0.9) 287(4; *) 289(1; *) 344(67; 8.6)
347(5; 0.9) 412(4; 0.5) 418(43; 7.7) 419(6; 1.8) 440(5; 0.9)

Table 3.--Continued

Peristedion miniatum--Cont.				
442(1; *)	449(1; *)	450(1; *)	451(10; 2.3)	538(91; 12.2)
539(2; 0.5)	604(1; 0.5)	605(29; 3.6)	606(8; 0.9)	607(1; *)
611(1; *)	673(1; *)	675(5; 0.9)	676(4; 0.9)	677(8; 1.8)
Prionotus carolinus, northern searobin				
19(1; *)	42(1; *)	43(1; *)	46(40; 6.8)	56(1; *)
57(1; *)	63(1; *)	68(1; *)	81(1; *)	82(3; 0.5)
84(9; 0.9)	85(3; 0.5)	86(4; 0.9)	92(1; *)	109(7; 1.4)
111(104; 17.7)	112(1; *)	117(22; 3.2)	118(1; *)	120(3; 0.5)
122(1; *)	137(30; 2.7)	138(12; 0.9)	139(1; *)	140(3; 0.5)
142(3; 0.5)	143(14; 1.8)	145(2; 0.5)	149(1; *)	168(3; 0.5)
169(10; 1.8)	170(2; 0.5)	172(3; 0.5)	197(1; *)	198(5; 0.5)
199(7; *)	200(13; *)	202(2; 0.5)	204(1; *)	205(24; 2.7)
206(15; 0.5)	207(4; *)	208(1; *)	209(16; *)	210(3; 0.5)
211(5; 0.5)	212(79; 3.2)	214(14; 1.8)	215(79; 3.6)	216(1; *)
217(1; 0.5)	232(3; 0.5)	233(65; 7.3)	234(9; 1.4)	235(25; 3.2)
236(4; 0.5)	259(3; 0.5)	260(18; *)	261(2; 0.5)	262(3; 0.5)
263(39; *)	264(15; *)	265(15; 0.5)	266(5; *)	268(1; *)
270(1; *)	271(1; *)	272(3; *)	273(4; *)	274(20; 0.5)
275(3; *)	276(12; 1.4)	277(11; 1.4)	278(2; *)	279(2; *)
281(1; 0.5)	283(1; *)	291(3; 0.9)	293(105; 5.4)	294(6; *)
295(24; 0.9)	296(1; *)	297(2; *)	298(1; *)	321(17; *)
323(1; *)	324(10; *)	328(2; 0.5)	329(5; *)	330(2; *)
331(1; *)	335(5; 0.9)	337(5; 0.9)	339(1; *)	340(1; *)
341(1; *)	342(3; *)	343(1; *)	349(2; 0.5)	350(9; 1.8)
353(5; *)	354(2; *)	356(2; *)	357(1; *)	398(1; *)
409(1; *)	410(86; 19.5)	413(1; *)	414(7; 1.8)	416(4; *)
421(3; *)	430(1; *)	432(2; *)	440(1; *)	442(1; *)
448(4; 1.4)	470(1; *)	489(1; *)	534(1; *)	535(4; 0.9)
540(14; 2.7)	541(1; *)	543(2; *)	567(1; *)	568(2; 0.5)
570(4; 0.5)	572(1; *)	581(1; *)	582(2; *)	585(1; *)
586(1; *)	589(5; 0.9)	590(3; 0.5)	592(1; *)	593(8; 2.3)
594(1; *)	597(1; *)	598(1; *)	599(1; *)	600(2; *)
601(2; *)	602(1; *)	614(1; *)	617(1; *)	619(1; *)
621(1; *)	622(1; *)	623(2; *)	624(8; 0.9)	625(5; *)
626(1; *)	637(2; *)	639(9; 0.5)	640(2; *)	641(1; *)
642(1; *)	643(6; 0.5)	644(10; 1.4)	645(4; *)	649(3; 0.5)
650(1; *)	653(1; *)	654(1; *)	655(4; *)	658(1; *)
661(1; *)	667(1; *)	683(20; 2.7)	684(6; 0.9)	685(3; *)
686(26; 2.3)	687(11; 0.9)	688(134; 16.8)	689(16; 1.4)	690(41; 5.4)
691(3; *)	697(1; *)	700(3; 0.5)		
Prionotus evolans, striped searobin				
17(1; *)	19(12; 5.0)	20(1; 0.5)	21(2; 1.4)	23(1; *)
29(1; *)	61(2; 0.9)	63(44; 3.6)	69(1; *)	81(1; 0.5)
85(3; 0.9)	86(1; 0.9)	90(8; 3.6)	92(3; 0.9)	109(3; 1.4)
111(38; 14.1)	112(3; 1.4)	113(1; *)	115(2; 0.5)	137(18; 7.3)
138(13; 5.4)	139(2; 0.5)	143(1; *)	144(8; 2.7)	145(2; *)
150(1; 0.5)	179(2; 0.5)	185(4; 1.4)	192(1; *)	195(1; *)
197(3; 0.9)	198(10; 0.5)	199(2; *)	200(14; 0.5)	201(1; *)
202(17; 0.9)	203(1; *)	205(3; *)	206(1; *)	207(1; *)
209(5; 0.5)	210(6; 2.3)	212(71; 10.4)	213(1; 0.5)	214(5; 0.5)
215(55; 23.6)	216(2; 0.9)	217(1; 0.9)	233(7; 0.5)	234(10; *)
237(1; *)	242(2; *)	243(1; *)	256(6; *)	258(1; *)

Table 3.--Continued

Prionotus evolans--Cont.

259(2; 0.5) 260(8; *) 261(2; *) 262(10; 4.5) 263(7; 2.7)
264(1; *) 265(3; 0.9) 266(3; 1.4) 269(17; 6.8) 270(1; *)
271(2; *) 272(9; 0.5) 273(5; 1.8) 274(13; 6.4) 276(7; 1.8)
278(1; *) 281(1; 0.5) 293(2; *) 294(1; 0.5) 295(8; 0.9)
298(4; *) 311(1; *) 318(1; *) 321(1; *) 323(6; *)
324(2; *) 325(1; *) 327(1; *) 328(2; 0.9) 332(2; *)
333(1; *) 336(1; 0.5) 337(3; 1.4) 338(13; 7.3) 339(7; 3.2)
340(4; 1.4) 341(1; *) 342(3; 0.9) 343(2; 1.4) 350(12; 6.8)
354(1; *) 356(1; *) 357(1; 0.5) 390(1; *) 540(1; *)
565(1; 0.5) 568(3; 1.8) 569(2; 0.9) 570(2; 0.9) 580(1; 0.5)
624(1; 0.5) 637(1; *) 638(1; *) 639(12; 4.5) 640(1; 0.5)
644(2; 0.5) 645(4; 2.3) 649(1; 0.5) 685(1; 0.5) 688(1; 0.5)
689(1; 0.9) 690(4; 0.9) 700(3; 1.4)

COTTIDAE

Hemitripterus americanus, sea raven

31(1; *) 42(1; *) 57(23; 18.1) 58(1; 0.5) 93(1; *)
105(1; *) 152(1; 0.5) 153(1; *) 157(1; 0.5) 167(1; *)
332(1; *) 336(3; 1.8) 397(1; *) 405(1; 0.9) 407(1; 0.5)
430(1; 1.4) 437(4; 2.3) 461(1; 0.9) 476(1; 0.5) 507(2; 2.3)
513(1; 0.5) 522(4; 2.3) 576(2; 1.8) 595(1; 0.5) 627(1; 0.5)
654(1; *) 692(1; 0.9) 695(1; *)

Myoxocephalus aenaeus, grubby

16(1; *) 68(1; *) 77(1; *) 195(2; *) 196(1; *) 302(2; *)
308(1; *) 312(1; *) 359(1; *) 361(2; *) 386(3; *) 387(5; *)
391(1; *) 484(1; *) 567(26; *)

Myoxocephalus octodecemspinosus, longhorn sculpin

55(1; *) 56(2; 0.5) 57(8; 2.3) 58(1; *) 87(1; *) 94(1; *)
105(7; *) 106(1; *) 107(4; *) 152(12; 0.5) 153(14; 0.9) 155(5; 0.9)
157(1; 0.5) 167(2; *) 168(1; *) 225(2; *) 226(2; *) 258(1; *)
280(2; *) 296(1; *) 320(32; 0.5) 333(1; *) 336(2; 1.8) 354(1; *)
376(1; 0.5) 388(4; *) 389(16; 3.6) 390(1; *) 391(4; 0.9) 392(3; 0.9)
393(1; *) 397(2; *) 398(1; *) 400(1; *) 405(2; 0.5) 429(1; 0.5)
430(1; *) 431(2; 0.5) 432(1; 0.5) 435(2; 0.5) 436(2; 0.5) 437(3; 0.5)
438(4; 0.9) 439(3; 0.5) 445(1; 0.5) 460(1; *) 462(1; *) 463(1; *)
464(1; *) 467(1; *) 476(1; *) 479(2; 0.5) 480(1; *) 483(1; *)
485(2; 0.5) 489(2; 0.5) 501(1; *) 502(4; 1.4) 503(6; 1.4) 504(2; *)
505(1; *) 510(2; 0.5) 511(1; 0.5) 512(5; 1.4) 513(3; 0.5) 522(1; *)
524(1; 0.5) 544(14; 1.8) 545(1; 0.5) 568(1; *) 575(2; 0.9) 577(1; *)
582(1; *) 584(1; *) 585(3; *) 586(8; 1.4) 587(5; 1.4) 588(1; 0.5)
591(4; 1.4) 594(1; *) 595(3; 0.9) 596(3; 0.9) 597(2; 0.5) 598(2; 0.5)
600(1; *) 608(1; 0.5) 617(2; 0.9) 619(2; 0.5) 620(2; 0.5) 621(1; *)
642(1; *) 654(1; *) 666(2; *)

Myoxocephalus scorpius, shorthorn sculpin

184(1; *)

CYCLOPTERIDAE

Liparis sp., seasnail

218(1; *) 225(1; *) 226(1; *) 334(1; *) 401(4; *) 426(1; *)
430(1; *) 439(6; *) 475(1; *)

Table 3.--Continued

THIDAE

Citharichthys arctifrons, Gulf Stream flounder

36(1; *) 37(2; *) 56(1; *) 94(9; *) 102(3; *)
104(47; *) 152(84; 0.5) 153(112; 0.9) 158(8; *) 160(56; 0.5)
161(108; 0.5) 162(51; *) 163(30; 0.5) 165(3; *) 167(51; 0.5)
168(1; *) 183(1; *) 217(104; 0.5) 218(46; *) 219(53; *)
221(13; *) 224(26; *) 225(8; *) 226(3; *) 280(4; *)
281(32; *) 285(16; *) 287(2; *) 289(24; *) 290(41; *)
340(8; *) 342(3; *) 343(3; *) 344(20; *) 346(4; *)
347(44; *) 348(196; *) 357(1; *) 410(20; *) 415(7; *)
416(14; *) 417(1; *) 421(73; *) 424(27; 0.5) 440(2; *)
444(104; *) 445(2; *) 449(2; *) 450(12; *) 451(4; *)
455(3; *) 457(1; *) 458(4; *) 531(1; *) 533(2; *)
535(1; *) 538(5; *) 539(6; *) 544(4; *) 545(1; *)
573(1; *) 602(2; *) 604(2; *) 605(1; *) 607(10; *)
608(4; *) 609(3; *) 610(1; *) 611(10; *) 612(1; *)
613(5; *) 615(3; *) 616(1; *) 619(6; *) 667(6; *)

Etropus microstomus, smallmouth flounder

21(2; *) 33(22; *) 34(9; *) 40(1; *) 41(1; *)
44(1; *) 59(2; *) 84(32; *) 85(2; *) 86(1; *)
90(19; *) 92(2; *) 93(14; *) 96(2; *) 97(4; *)
99(16; 0.9) 100(22; *) 105(15; *) 106(3; *) 115(1; *)
117(8; *) 138(2; *) 139(4; *) 140(1; *) 142(1; *)
143(10; *) 144(14; *) 145(2; *) 155(1; *) 156(3; *)
157(4; *) 166(1; *) 179(1; *) 197(1; *) 198(1; *)
200(8; *) 201(1; *) 202(7; *) 203(1; *) 206(1; *)
207(2; *) 208(7; *) 209(8; *) 210(2; *) 212(44; *)
214(3; *) 215(141; 1.4) 223(14; *) 227(1; *) 228(3; *)
229(1; *) 233(6; *) 234(17; *) 235(3; *) 237(1; *)
238(1; *) 242(1; *) 243(1; *) 256(25; *) 257(20; *)
258(3; *) 259(3; *) 260(32; *) 261(38; *) 263(115; *)
264(22; *) 265(24; *) 266(1; *) 270(2; *) 271(6; *)
272(96; *) 273(36; *) 274(6; *) 275(34; *) 277(4; *)
278(3; *) 293(42; *) 294(34; *) 295(1; *) 296(24; *)
309(2; *) 316(4; *) 318(54; *) 319(11; *) 320(8; *)
321(66; *) 322(81; *) 323(13; *) 324(2; *) 325(30; *)
326(19; 0.5) 327(261; 0.5) 329(2; *) 331(14; *) 332(46; *)
333(28; *) 334(1; *) 335(1; *) 337(7; *) 338(19; *)
361(1; *) 392(20; *) 393(11; *) 394(4; *) 395(4; *)
396(1; *) 397(12; *) 398(1; *) 405(1; *) 407(4; *)
409(1; *) 422(4; *) 426(7; *) 427(14; *) 428(10; *)
429(2; *) 430(14; *) 431(31; *) 432(7; *) 433(2; *)
434(3; *) 435(2; *) 437(1; *) 438(7; *) 461(7; *)
462(7; *) 463(10; *) 464(2; *) 466(2; *) 467(1; *)
470(2; *) 475(8; *) 476(1; *) 477(3; *) 479(3; *)
480(1; *) 482(1; *) 484(3; *) 502(5; *) 503(1; *)
504(9; *) 505(21; *) 506(1; *) 507(3; *) 509(1; *)
513(3; *) 516(1; *) 521(11; *) 525(1; *) 572(4; *)
574(2; *) 576(15; 0.5) 577(2; *) 582(2; *) 583(17; 0.5)
584(9; *) 585(3; *) 596(5; *) 597(6; *) 599(1; *)
600(6; *) 603(1; *) 614(1; *) 615(1; *) 621(1; *)

Table 3.--Continued

Etropus microstomus--Cont.
622(7; *) 623(19; *) 624(4; *) 639(2; *) 640(10; *)
641(2; *) 642(9; *) 643(25; *) 644(7; *) 645(6; *)
646(3; *) 651(1; *) 652(2; *) 655(1; *) 656(5; *)
657(1; *) 658(6; *) 659(1; *) 661(1; *) 666(6; *)
668(3; *) 669(1; *) 671(13; *) 672(30; *) 673(33; *)
674(50; *) 675(4; *) 676(2; *) 677(5; *) 678(9; *)
679(4; *) 680(4; *) 681(20; *) 685(1; *) 686(1; *)
687(17; *) 688(10; *) 689(4; *) 690(9; *) 691(1; *)
692(2; *) 693(2; *) 694(3; *) 695(3; *)

Monolene sessilicauda, deepwater flounder
102(1; *)

Hippoglossina oblonga, fourspot flounder (See: Gutherz 1967)
19(8; 0.9) 29(11; 1.8) 21(28; 4.1) 22(18; 2.3) 28(1; *)
31(5; 0.9) 32(6; 0.9) 34(3; 0.5) 37(2; *) 42(9; 0.9)
43(31; 3.6) 44(8; 0.9) 45(3; 0.5) 46(13; 2.3) 53(1; 0.5)
54(1; 0.5) 55(9; 0.9) 56(4; 0.5) 57(6; 0.5) 58(16; 0.9)
59(8; 1.4) 60(3; 0.5) 80(1; *) 82(8; 0.5) 83(2; *)
84(3; *) 85(2; 0.5) 86(53; 5.9) 87(40; 5.4) 88(2; *)
89(7; 0.9) 91(7; 0.9) 93(41; 5.0) 94(7; 1.4) 96(19; 2.3)
97(10; 0.9) 98(10; 1.4) 100(1; *) 101(2; 0.5) 104(26; 3.2)
105(35; 5.4) 106(42; 5.0) 107(11; 1.4) 112(38; 3.6) 113(7; 0.5)
114(7; 0.5) 115(54; 7.3) 116(35; 4.5) 117(46; 5.0) 119(3; *)
141(4; *) 142(40; *) 143(3; *) 144(5; *) 145(21; *)
146(16; 1.4) 147(1; *) 149(2; *) 152(65; 10.9) 153(71; 9.5)
154(1; *) 155(13; 1.4) 156(9; 1.4) 157(3; 0.5) 158(23; 3.2)
159(8; 0.9) 160(44; 6.8) 161(11; 1.4) 162(1; 0.5) 166(14; 1.8)
167(22; 2.7) 175(4; *) 176(6; 0.5) 177(20; 1.8) 178(2; *)
179(1; *) 180(1; *) 181(1; *) 200(4; *) 201(5; *)
202(16; *) 204(15; *) 205(11; *) 206(4; *) 208(1; *)
209(7; *) 212(25; *) 213(26; 0.5) 214(28; 0.5) 215(74; 0.5)
217(9; 0.9) 218(4; 0.9) 223(97; 11.3) 224(59; 7.7) 225(50; 6.8)
226(115; 18.1) 227(47; 6.4) 228(12; 1.4) 229(6; 0.9) 230(18; 2.3)
231(2; *) 233(10; *) 234(3; *) 235(7; *) 236(2; *)
260(15; *) 261(8; *) 262(45; 0.5) 263(40; *) 264(34; *)
265(30; *) 266(4; *) 270(4; *) 271(7; *) 272(74; 0.9)
273(29; 0.5) 274(46; 0.5) 275(66; 0.9) 276(15; 2.7) 277(22; 0.9)
278(1; *) 280(61; 9.1) 281(30; 5.9) 282(19; 3.6) 283(8; 0.9)
285(13; 1.4) 287(3; 0.5) 288(2; 0.5) 290(5; 0.5) 291(54; 9.1)
292(9; 1.8) 293(24; 0.5) 294(20; 0.5) 295(7; *) 296(5; 0.5)
297(3; *) 321(5; *) 322(4; *) 323(38; 0.5) 324(34; *)
328(11; 1.8) 329(4; *) 330(42; 1.4) 335(14; 2.3) 336(7; 1.4)
337(60; 8.2) 338(79; 11.8) 339(6; 0.9) 340(100; 10.9) 341(20; 0.5)
342(62; 7.7) 343(41; 5.4) 344(1; *) 347(1; *) 348(2; *)
349(30; 3.6) 350(10; 1.8) 353(8; *) 354(6; *) 356(17; *)
357(17; 0.9) 397(4; *) 398(18; 0.5) 406(7; *) 407(3; 0.5)
409(9; 1.4) 410(20; 4.5) 411(12; 2.7) 412(10; 1.4) 413(1; *)
414(7; 0.9) 415(20; 4.1) 416(22; 4.1) 421(37; 5.0) 422(53; 7.3)
423(7; 0.5) 424(2; 0.5) 430(1; *) 431(1; *) 432(6; *)
434(1; *) 437(1; *) 439(1; *) 440(35; 7.3) 441(7; 2.3)
442(15; 2.3) 443(2; *) 444(14; 1.8) 445(2; *) 446(1; *)
447(12; 1.8) 448(17; 2.7) 449(4; 1.4) 450(1; *) 452(9; 1.4)

Table 3.--Continued

Hippoglossina oblonga--Cont.				
453(6; 0.9)	455(7; 0.9)	456(7; 1.4)	457(6; 0.9)	477(1; *)
479(1; *)	503(1; 0.5)	513(5; 0.5)	516(1; *)	522(4; 0.5)
526(1; *)	528(5; 0.9)	529(2; *)	530(2; 0.5)	532(2; *)
533(3; 0.5)	534(5; 0.9)	535(61; 8.2)	538(7; 1.8)	539(10; 2.3)
540(13; 1.8)	541(3; 0.5)	542(2; 0.5)	543(9; 1.8)	544(5; 1.4)
545(13; 1.8)	569(2; 0.9)	570(2; 0.5)	571(6; 1.4)	573(1; *)
575(10; 1.8)	576(13; 0.9)	578(1; *)	579(4; 0.5)	580(1; *)
581(1; *)	582(3; *)	583(6; 0.5)	584(11; 3.2)	585(13; 1.8)
586(35; 4.1)	587(9; 1.8)	588(1; *)	589(4; 0.9)	590(3; 0.9)
592(6; 0.9)	593(3; 0.9)	594(14; 2.7)	595(17; 3.6)	596(26; 3.2)
597(20; 2.3)	598(16; 2.3)	599(7; 0.9)	600(30; 5.0)	601(98; 13.2)
602(68; 7.3)	603(29; 3.6)	604(10; 1.8)	605(6; 2.3)	606(12; 1.8)
607(3; 0.9)	608(6; 1.8)	609(8; 1.4)	610(9; 1.8)	613(2; *)
614(11; 1.4)	615(21; 2.7)	616(14; 1.8)	617(4; 0.9)	618(4; 0.5)
619(21; 3.6)	620(9; 1.8)	621(7; 0.9)	622(5; 0.9)	627(3; 0.5)
638(6; 0.9)	640(13; 2.3)	641(27; 5.4)	642(31; 5.0)	643(54; 9.5)
644(7; 1.4)	645(4; 0.9)	647(2; *)	650(10; 2.3)	652(10; 1.8)
653(10; 0.9)	654(72; 10.0)	655(7; 1.4)	656(4; 0.5)	657(8; 1.4)
658(40; 5.4)	659(4; 0.5)	660(3; 0.5)	661(11; 1.8)	662(3; *)
663(7; 0.9)	664(3; *)	665(16; 2.3)	666(33; 5.0)	667(10; 1.4)
668(19; 2.7)	670(4; 0.5)	671(18; 2.3)	672(11; 1.8)	673(28; 3.6)
674(18; 1.8)	675(26; 6.8)	676(1; *)	677(2; *)	678(27; 4.1)
679(25; 3.6)	680(9; 1.4)	681(13; 1.4)	682(7; 0.9)	683(4; 0.5)
685(6; 0.9)	686(7; 0.9)	687(19; 2.3)	688(27; 4.5)	689(2; *)
690(26; 5.0)	691(41; 5.4)	692(22; 5.0)	693(38; 9.1)	694(11; 1.8)
695(7; 1.8)	696(1; *)	697(8; 1.4)	698(4; 0.5)	700(7; 0.9)
Paralichthys dentatus, summer flounder				
9(2; 0.9)	16(4; 3.2)	17(9; 10.0)	18(3; 3.2)	19(8; 6.4)
20(4; 3.6)	21(21; 14.5)	23(3; 2.7)	28(6; 9.5)	29(2; *)
42(2; 0.9)	43(1; 0.5)	45(3; 1.4)	46(8; 8.6)	47(2; 1.4)
48(5; 7.3)	50(8; 5.4)	52(12; 6.8)	53(5; 2.3)	55(2; 1.4)
56(3; 1.8)	57(1; 0.5)	59(1; 0.5)	61(8; 10.9)	62(1; 0.5)
63(12; 2.7)	64(2; 1.4)	67(5; 3.2)	69(5; 4.1)	70(12; 8.2)
71(1; *)	72(1; *)	76(1; 0.9)	77(4; 5.0)	78(16; 21.8)
79(8; 5.9)	80(1; 1.4)	81(10; 10.9)	84(2; 2.7)	85(1; 1.4)
90(40; 38.6)	92(27; 36.3)	111(1; 0.5)	115(2; 0.9)	120(1; 1.8)
122(3; 2.3)	123(7; 5.0)	134(1; 0.5)	135(1; 0.5)	137(50; 41.3)
138(16; 10.9)	139(3; 2.7)	140(16; 16.8)	142(1; 0.9)	143(3; 2.7)
144(8; 10.0)	150(3; 3.2)	184(1; 0.9)	185(1; 0.5)	186(2; 0.9)
187(4; 2.7)	189(2; 1.8)	192(3; 1.8)	193(6; 5.4)	194(2; 1.4)
195(7; 5.4)	196(21; 14.5)	197(35; 27.2)	198(13; 10.9)	199(17; 15.4)
200(2; 1.4)	202(16; 1.4)	203(1; 0.9)	204(4; 4.1)	205(3; 2.7)
206(11; 14.1)	207(15; 14.5)	208(3; 3.2)	209(40; 38.1)	210(9; 10.0)
211(4; 2.3)	212(11; 12.7)	213(5; 8.6)	214(9; 16.8)	215(18; 17.7)
217(1; 0.5)	232(17; 7.7)	233(70; 54.9)	234(22; 16.8)	235(10; 16.8)
236(5; 9.1)	237(1; *)	238(3; *)	242(3; *)	243(1; *)
256(20; 1.8)	257(4; 0.5)	258(1; *)	259(5; 2.7)	260(3; 1.8)
261(9; 3.6)	262(22; 7.7)	263(8; 3.6)	264(2; 1.4)	266(2; 2.3)
267(16; 21.3)	268(4; 7.3)	269(2; 1.4)	270(5; 3.2)	271(8; 6.4)
272(4; 0.9)	273(2; 0.5)	274(5; 2.7)	275(2; *)	276(4; 4.1)
277(15; 18.6)	278(3; 1.8)	279(2; 1.8)	280(2; 1.8)	281(2; 2.7)
282(1; 2.3)	288(1; 2.3)	290(1; 4.1)	291(2; 3.2)	293(13; 5.9)
294(2; 1.8)	295(10; 10.0)	297(3; 2.7)	298(14; *)	300(1; *)

Table 3.--Continued

Paralichthys dentatus--Cont.
312(1; *) 318(2; *) 320(6; *) 321(21; 1.8) 322(2; *)
323(10; 0.5) 324(4; 2.3) 325(3; *) 326(20; 0.9) 327(1; *)
328(14; 15.4) 329(1; *) 330(4; 3.2) 331(2; 2.7) 332(13; 5.0)
333(7; 6.4) 334(21; 10.4) 335(7; 4.5) 337(2; 8.6) 338(2; 2.3)
340(3; 4.1) 341(5; 3.6) 343(3; 2.7) 349(5; 5.9) 351(1; *)
352(1; 0.9) 353(2; 0.9) 354(8; 1.8) 356(1; *) 357(1; 0.5)
387(1; *) 389(1; *) 390(1; *) 393(1; *) 394(1; *)
395(1; *) 398(1; *) 404(1; *) 405(2; *) 406(1; *)
410(3; 1.8) 413(21; 21.8) 415(1; *) 416(2; 1.8) 428(1; *)
436(1; *) 437(1; *) 438(4; *) 442(3; 5.9) 447(1; 1.4)
448(18; 14.5) 449(1; 0.9) 451(1; 1.8) 454(1; *) 486(1; *)
487(2; *) 503(1; *) 521(1; *) 522(1; *) 532(4; 9.5)
533(9; 11.8) 535(7; 4.1) 539(2; 4.1) 540(2; 0.9) 542(1; *)
543(2; 0.5) 545(2; 1.4) 546(1; *) 556(1; 0.5) 567(1; 0.5)
568(1; *) 569(6; 3.2) 570(37; 11.8) 571(1; 0.5) 572(2; 0.9)
573(2; 1.4) 577(4; 2.3) 579(6; 2.7) 580(3; 1.4) 581(1; *)
582(1; 0.5) 583(1; 0.9) 584(1; 2.7) 585(4; 3.2) 586(1; 0.5)
589(3; 1.8) 592(4; 4.5) 593(6; 5.0) 594(3; 2.3) 595(1; 0.5)
599(1; 0.5) 600(1; 0.5) 601(3; 3.2) 615(2; 1.8) 616(1; 0.5)
619(1; 1.4) 620(1; *) 622(1; *) 623(11; 4.1) 624(26; 8.6)
625(24; 8.2) 626(7; 1.4) 627(1; 0.9) 628(2; 0.9) 629(2; 0.9)
634(2; 0.9) 635(2; *) 637(59; 25.9) 638(6; 3.2) 639(34; 15.4)
640(4; 2.3) 641(7; 3.6) 642(2; 0.9) 643(12; 6.8) 644(96; 54.0)
645(38; 20.0) 646(60; 38.1) 648(3; 1.8) 649(23; 16.3) 650(9; 5.9)
651(2; 2.7) 653(12; 12.7) 655(38; 28.1) 660(1; 0.9) 663(1; 0.9)
670(1; 3.6) 683(3; *) 684(15; 7.3) 685(9; 6.8) 687(11; 5.4)
688(11; 4.5) 689(10; 5.0) 690(48; 28.1) 691(24; 12.2) 692(4; 3.2)
693(3; 1.4) 694(4; 1.8) 696(3; 1.4) 697(4; 2.7) 698(4; 2.3)
699(1; 1.4) 700(52; 29.5)

Scophthalmus aquosus, windowpane
9(1; 0.5) 14(14; 2.7) 16(3; 0.5) 17(10; 1.8) 19(52; 10.9)
20(19; 5.4) 21(51; 14.1) 22(1; 0.5) 23(2; *) 24(1; *)
25(1; *) 27(2; 0.5) 28(22; 5.4) 29(10; 2.7) 30(1; *)
42(14; 3.6) 43(6; 1.4) 44(57; 11.8) 45(71; 16.8) 46(263; 58.5)
47(10; 2.3) 48(9; 1.8) 49(3; 0.5) 50(2; 0.5) 51(1; *)
52(5; 1.4) 53(2; 0.5) 55(5; 0.9) 57(2; 0.5) 58(1; 0.5)
59(6; 1.4) 60(2; 0.5) 62(1; *) 70(2; *) 71(1; *)
72(1; *) 80(31; 7.3) 81(14; 4.1) 82(16; 3.2) 83(10; 2.7)
84(62; 10.4) 85(52; 10.9) 86(46; 10.9) 87(22; 5.4) 90(13; 3.2)
91(2; 0.5) 92(23; 4.5) 93(13; 4.1) 94(1; 0.5) 105(7; 1.8)
106(9; 1.4) 107(6; 1.4) 108(2; *) 109(3; 0.5) 110(1; *)
111(8; 2.3) 112(23; 4.5) 113(2; 0.5) 114(5; 1.4) 115(106; 23.6)
116(199; 42.2) 117(135; 26.3) 118(7; 1.4) 119(10; 2.3) 120(17; 3.2)
122(1; *) 123(1; *) 137(20; 4.5) 138(9; 0.9) 139(12; 0.5)
140(7; 1.4) 141(41; 9.5) 142(29; 5.9) 143(22; 3.2) 144(10; 1.8)
145(18; 4.1) 146(2; 0.5) 147(1; *) 149(1; *) 150(13; 2.3)
151(1; *) 152(6; 1.4) 153(21; 4.5) 155(5; 0.9) 156(12; 2.3)
167(18; 4.1) 168(8; 1.4) 171(1; *) 172(1; *) 174(2; *)
175(1; *) 176(1; 0.5) 177(10; 1.8) 178(18; 4.5) 179(17; 3.6)
180(25; 5.9) 181(21; 4.5) 186(2; *) 189(1; *) 194(1; *)
197(23; 4.1) 198(10; 2.3) 199(59; 7.3) 200(83; 17.7) 201(10; 2.3)
202(14; 1.8) 203(3; 0.5) 204(14; 2.3) 205(3; 0.5) 207(15; 2.3)
208(4; 0.9) 209(33; 4.5) 210(10; 1.4) 211(10; 2.3) 212(57; 9.1)

Table 3.--Continued

Scophthalmus aquosus--Cont.

213(34; 6.8)	214(17; 3.6)	215(128; 19.1)	216(4; 0.9)	225(1; *)
226(10; 2.7)	227(10; 1.8)	228(9; 1.8)	229(2; *)	230(7; 2.3)
231(3; 0.5)	232(19; 2.7)	233(70; 11.8)	234(77; 18.1)	235(53; 10.0)
236(54; 11.8)	237(2; *)	238(1; *)	240(1; *)	242(37; 9.1)
243(3; *)	251(3; *)	253(1; *)	254(6; 1.4)	256(52; 5.9)
257(25; 2.3)	258(1; *)	259(4; *)	260(75; 5.9)	261(52; 8.2)
262(356; 58.5)	263(49; 5.4)	264(29; 13.2)	265(33; 7.3)	266(9; 1.4)
267(1; *)	268(6; 0.9)	270(12; 2.3)	271(7; 1.4)	272(150; 22.7)
273(21; 3.2)	274(33; 6.8)	275(75; 9.5)	276(44; 8.6)	277(45; 10.4)
278(22; 3.6)	279(36; 6.8)	280(4; 0.5)	281(7; 1.8)	293(108; 20.4)
294(57; 10.0)	295(118; 20.9)	297(21; 4.1)	298(59; 9.1)	299(17; 2.3)
300(9; 0.5)	301(1; *)	303(1; *)	304(1; *)	305(1; *)
306(5; *)	307(2; 0.5)	308(2; *)	309(3; *)	310(1; *)
311(12; 1.8)	312(2; *)	314(1; *)	315(2; *)	316(41; 3.6)
317(7; *)	318(71; 9.1)	319(95; 9.5)	320(70; 9.1)	321(151; 21.3)
322(178; 20.4)	323(240; 20.0)	324(54; 12.7)	325(103; 21.8)	326(13; 2.3)
327(39; 5.0)	328(5; 1.4)	329(6; 0.9)	330(62; 12.7)	331(62; 9.1)
332(115; 21.8)	333(109; 18.6)	334(36; 33.1)	335(4; 0.9)	341(53; 10.0)
342(12; 4.1)	343(1; *)	351(1; *)	352(4; 0.5)	353(53; 10.9)
354(57; 10.9)	356(59; 7.3)	357(52; 10.4)	359(1; *)	360(1; 0.5)
375(1; *)	383(1; *)	386(29; 1.8)	387(14; 1.4)	388(3; 0.5)
389(13; 1.8)	390(14; 4.5)	391(62; 12.2)	392(64; 10.4)	393(51; 7.7)
394(55; 8.6)	395(46; 5.0)	396(13; 1.8)	397(26; 4.1)	398(53; 12.2)
399(36; 5.0)	400(25; 6.8)	401(3; 0.9)	402(5; 0.9)	403(7; 0.9)
404(1; *)	405(24; 4.5)	406(39; 8.6)	407(22; 5.0)	409(2; 0.5)
415(8; 2.7)	423(10; 2.3)	425(59; 13.6)	426(45; 10.9)	427(39; 10.4)
428(40; 11.8)	429(13; 3.6)	430(18; 3.6)	431(47; 10.0)	432(10; 1.8)
433(6; 1.8)	434(27; 7.3)	435(39; 7.7)	436(9; 1.8)	437(2; *)
438(42; 9.1)	443(16; 2.7)	444(5; 1.8)	445(15; 3.2)	446(5; 1.4)
454(5; 1.4)	455(6; 1.8)	459(35; 3.2)	460(19; 7.7)	461(22; 5.9)
462(22; 4.5)	463(4; *)	464(4; 0.9)	465(1; *)	466(13; 3.2)
467(14; 4.1)	470(17; 3.6)	471(6; 0.9)	472(10; 2.3)	473(5; 0.9)
474(23; 6.8)	475(8; 1.8)	477(4; 0.9)	478(6; 1.4)	479(14; 2.7)
480(9; 2.3)	481(3; 0.9)	482(6; 1.4)	484(3; 1.4)	485(2; 0.5)
487(2; 0.5)	490(3; *)	498(1; *)	500(1; *)	501(3; 0.5)
502(58; 14.5)	503(46; 13.2)	504(63; 15.4)	505(53; 9.5)	506(20; 5.0)
507(75; 15.9)	508(26; 7.3)	509(49; 15.0)	510(30; 8.6)	511(89; 22.2)
512(6; 1.8)	513(12; 2.7)	515(5; 1.8)	516(2; 0.5)	517(21; 6.4)
518(29; 8.3)	519(9; 2.3)	520(2; 0.5)	521(30; 5.9)	522(1; *)
523(32; 6.4)	524(10; 3.2)	525(4; 0.9)	526(9; 2.7)	527(4; 1.4)
542(7; 1.8)	543(2; 0.5)	544(2; 0.5)	545(4; 1.4)	546(12; 2.7)
553(1; *)	554(6; 0.9)	556(5; 0.5)	557(1; *)	559(2; 0.5)
560(9; 1.4)	561(3; 0.9)	562(22; 4.5)	563(8; 1.4)	564(1; *)
565(6; 0.9)	566(4; 0.9)	567(7; 1.8)	568(64; 4.5)	569(98; 24.0)
570(268; 60.3)	571(12; 2.3)	572(55; 12.7)	573(23; 6.4)	574(19; 3.6)
575(4; 1.4)	577(38; 8.2)	578(14; 3.6)	579(98; 20.4)	580(91; 21.8)
581(113; 25.9)	582(227; 53.5)	583(171; 12.2)	584(49; 12.7)	585(12; 2.7)
586(5; 1.4)	587(8; 2.7)	588(30; 7.7)	589(56; 15.0)	590(264; 32.7)
591(18; 4.5)	592(58; 14.1)	593(50; 11.3)	594(65; 15.4)	595(18; 3.6)
596(2; *)	598(1; *)	599(1; 0.5)	616(1; *)	617(8; 2.7)
618(1; *)	620(5; 1.8)	621(9; 2.3)	622(29; 7.3)	623(57; 13.6)
624(107; 24.0)	625(90; 18.1)	626(7; 2.3)	627(3; 0.5)	628(2; 0.5)
629(2; *)	634(1; *)	635(4; *)	637(36; 8.2)	638(71; 14.5)
639(385; 71.2)	640(29; 5.4)	641(18; 4.5)	642(14; 2.3)	643(107; 17.7)

Scophthalmus aquosus--Cont.

644(543; 67.6)	645(101; 20.4)	646(66; 15.0)	647(12; 2.7)	648(24; 5.9)
649(128; 32.7)	650(180; 38.6)	651(34; 8.2)	652(1; 0.5)	653(74; 19.5)
654(2; 0.5)	655(96; 23.1)	658(2; 0.9)	659(1; *)	660(1; *)
662(4; 0.9)	663(1; *)	683(15; 3.2)	684(15; 3.2)	685(209; 43.5
686(15; 3.6)	687(52; 12.7)	688(106; 25.9)	689(403; 80.7)	690(778; 144.
691(40; 9.1)	692(4; 0.9)	693(4; 0.9)	694(13; 3.2)	695(1; *)
696(1; *)	697(3; 0.5)	699(16; 4.1)	700(207; 43.5)	

PLEURONECTIDAE

Glyptocephalus cynoglossus, witch flounder

160(1; 0.9)	163(5; 0.5)	164(8; 0.5)	206(6; 0.9)	228(2; 0.9)
286(43; 5.0)	296(3; 1.4)	330(1; 0.5)	337(1; *)	339(1; 0.5)
340(1; 0.5)	346(229; 122.5)	396(1; 0.5)	416(1; 0.5)	417(36; 13.2)
420(28; 5.0)	421(1; *)	437(1; 1.4)	441(1; *)	458(3; 0.5)
522(1; *)	531(8; 1.4)	535(1; *)	537(5; 0.9)	601(6; 2.7)
604(1; *)	605(1; *)	609(1; *)	612(35; 3.2)	613(2; 0.5)
616(1; 0.5)	619(2; 0.9)	662(1; 0.5)	668(1; 0.9)	669(2; *)
671(1; *)	672(1; *)	673(5; 1.4)	674(2; 0.9)	677(1; *)

Limanda ferruginea, yellowtail flounder

27(1; 0.5)	31(10; 3.2)	41(1; 0.5)	53(1; *)	55(3; *)
57(4; 0.9)	58(14; 0.9)	87(4; *)	93(1; *)	94(4; 0.9)
96(1; 0.5)	104(1; *)	105(7; 0.5)	106(4; 0.5)	113(1; *)
114(2; *)	115(2; *)	141(1; *)	152(34; 2.7)	153(20; 1.4)
155(1; *)	156(3; 0.5)	177(1; *)	178(1; *)	202(1; *)
217(1; 0.5)	223(6; *)	224(101; 9.1)	225(207; 17.2)	226(44; 7.3)
227(2; *)	230(1; *)	260(20; *)	261(1; *)	264(8; *)
280(4; 0.9)	281(6; 0.9)	282(6; 1.8)	283(13; 1.8)	292(7; 3.2)
293(1; *)	321(5; *)	322(1; *)	324(1; 0.5)	327(1; *)
329(3; 1.4)	330(8; 3.2)	331(2; 0.5)	335(10; 3.2)	336(3; 0.9)
337(2; 0.5)	338(8; 0.9)	339(1; 0.5)	341(3; 0.9)	342(7; 3.2)
343(2; 0.5)	351(1; *)	353(2; 0.5)	354(1; *)	357(8; 2.3)
391(1; *)	392(15; 7.3)	393(19; 5.9)	394(8; 1.8)	395(21; 7.7)
396(39; 14.5)	397(41; 12.7)	398(44; 9.5)	399(17; 5.0)	400(7; 2.7)
402(2; 0.5)	403(48; 18.1)	404(1; 0.5)	405(41; 15.0)	406(81; 22.7)
407(23; 6.8)	408(2; 0.9)	409(9; 4.1)	415(3; 0.9)	421(1; 0.5)
423(8; 3.2)	425(7; 2.7)	426(1; 0.5)	427(5; 2.3)	428(8; 4.5)
429(5; 2.3)	430(22; 10.0)	431(14; 6.8)	432(1; 0.5)	433(37; 14.5)
434(25; 8.6)	435(90; 32.7)	436(17; 6.8)	437(78; 30.8)	438(11; 4.1)
443(8; 2.3)	444(6; 2.3)	445(2; 0.9)	446(4; 1.4)	447(3; 1.4)
452(10; 5.4)	453(5; 2.3)	454(4; 1.4)	460(1; 0.5)	461(1; *)
462(2; 1.4)	463(27; 10.9)	464(15; 4.1)	465(1; *)	467(3; 0.9)
470(1; 0.5)	471(1; *)	472(1; 0.5)	476(1; *)	477(7; 2.3)
478(7; 2.7)	479(41; 11.3)	480(2; 0.5)	481(5; 2.3)	485(1; 0.5)
501(3; *)	502(2; 0.9)	505(12; 1.8)	506(26; 8.6)	507(26; 7.7)
508(32; 11.3)	509(5; 1.8)	510(9; 3.2)	511(2; 0.5)	512(18; 6.8)
513(24; 6.4)	515(13; 3.2)	516(10; 3.2)	517(1; 0.9)	519(1; 0.5)
520(2; 1.4)	521(4; 1.4)	522(24; 8.2)	523(18; 4.5)	524(3; 1.4)
525(1; *)	526(20; 8.6)	527(13; 3.2)	529(4; 1.8)	542(1; *)
543(2; 0.9)	544(14; 5.4)	545(6; 2.3)	546(26; 7.3)	547(1; *)
572(15; 3.6)	573(4; 0.5)	574(20; 2.3)	575(26; 6.8)	576(2; 0.9)
577(12; 3.6)	578(3; 1.4)	582(2; *)	583(1; 0.5)	584(8; 2.3)
585(189; 28.6)	586(67; 12.2)	587(54; 17.2)	588(19; 6.4)	590(1; 0.5)

Table 3.--Continued

Limanda ferruginea--Cont.

591(3; 0.9)	594(23; 8.2)	595(51; 14.5)	596(24; 6.4)	597(40; 11.3)
598(27; 9.5)	599(32; 11.3)	600(14; 5.0)	601(47; 22.2)	602(3; 1.4)
608(4; 1.8)	616(3; 1.4)	617(2; 0.9)	618(5; 1.8)	619(9; 4.1)
620(8; 2.3)	621(5; 1.4)	622(2; 0.5)	627(17; 6.8)	641(2; *)
642(6; *)	643(1; *)	652(33; 10.0)	653(1; 0.5)	654(34; 12.2)
655(1; 0.5)	656(16; 11.8)	657(7; 3.2)	658(64; 6.4)	659(19; 3.2)
660(3; 0.5)	661(3; *)	662(2; 0.9)	665(8; 4.1)	666(11; 4.1)
667(3; 1.4)	668(1; *)	681(1; 0.5)	687(2; *)	694(1; *)
695(7; *)	696(3; *)	697(1; *)	698(1; *)	

Pseudopleuronectes americanus, winter flounder

3(3; *)	4(3; 0.5)	6(1; *)	9(2; 0.5)	10(25; 3.2)
11(1; *)	12(1; *)	16(11; 1.4)	17(21; 2.3)	18(6; 0.5)
19(12; 1.4)	20(9; 1.8)	21(49; 9.5)	22(5; 1.4)	23(5; 1.4)
24(9; 2.3)	25(23; 5.9)	26(2; 0.5)	27(24; 6.4)	28(4; 1.4)
29(1; *)	30(8; 2.7)	31(1; 0.5)	41(1; 0.5)	42(1; 0.5)
43(8; 2.7)	44(25; 9.1)	45(10; 2.7)	46(5; 0.9)	47(5; 1.4)
48(4; 0.9)	50(3; 0.9)	51(5; 1.4)	52(35; 10.9)	53(122; 34.9)
55(7; 2.7)	56(9; 4.5)	57(10; 4.5)	59(7; 3.2)	60(4; 0.5)
61(1; *)	62(15; 0.9)	63(13; 0.9)	66(1; *)	67(3; *)
68(7; *)	69(4; 0.5)	70(25; 2.3)	71(2; *)	72(2; *)
73(1; *)	77(3; *)	78(3; *)	79(13; 1.4)	80(4; 1.4)
81(9; 3.2)	83(2; 0.5)	85(10; 2.3)	86(6; 0.9)	87(18; 4.5)
90(3; 0.5)	93(1; 0.5)	94(7; 2.3)	105(7; 2.7)	106(7; 2.3)
107(3; 0.9)	112(7; 1.8)	115(14; 1.8)	116(3; 0.5)	119(1; *)
135(1; *)	136(3; 0.5)	142(3; 0.5)	146(1; *)	149(1; *)
152(7; 1.8)	153(2; 0.5)	154(5; 1.4)	155(3; 0.9)	156(2; 0.5)
157(1; 0.5)	168(1; *)	171(1; *)	175(3; 0.5)	177(1; *)
178(2; *)	179(2; *)	180(2; 0.5)	183(1; *)	184(4; 0.5)
185(5; 0.5)	186(2; *)	187(4; 0.5)	188(3; *)	189(1; *)
190(3; *)	192(14; 1.4)	193(2; *)	195(8; 0.5)	196(16; 0.9)
199(1; *)	200(1; *)	211(1; *)	226(1; *)	227(4; 1.8)
228(5; 1.4)	229(3; 0.5)	230(5; 1.4)	231(1; *)	236(3; 0.5)
237(2; *)	238(7; 0.5)	239(3; *)	240(3; *)	241(4; 0.5)
242(26; 4.1)	243(35; 5.0)	244(44; 5.0)	245(2; 0.5)	246(57; 4.5)
247(7; 0.9)	248(16; 0.9)	249(27; 2.7)	250(10; 0.9)	254(1; *)
256(12; 1.4)	257(43; 3.2)	258(80; 9.5)	259(8; 2.3)	260(9; 0.5)
262(2; *)	263(3; *)	266(4; 0.5)	267(2; 0.9)	268(2; 0.5)
269(1; *)	271(3; 0.9)	272(2; 0.5)	273(1; 0.5)	274(1; *)
277(3; 0.5)	280(3; 0.9)	281(1; *)	282(2; 0.9)	283(1; *)
292(3; 1.4)	293(2; 0.5)	295(9; 1.8)	296(2; *)	298(18; 6.8)
299(14; 1.4)	300(14; *)	301(11; 0.9)	302(7; *)	305(2; *)
306(2; *)	307(8; 0.9)	308(13; 2.3)	309(5; 0.5)	310(27; 5.0)
311(49; 2.7)	312(32; 3.6)	313(3; 0.5)	314(39; 2.7)	315(6; 0.9)
316(49; 5.9)	317(35; 5.4)	318(85; 3.2)	319(117; 4.1)	320(122; 14.5)
321(6; 0.9)	322(3; *)	323(12; 1.8)	324(6; 2.3)	325(5; 1.4)
326(6; 1.8)	327(4; 0.9)	328(2; 0.5)	329(3; 0.9)	330(36; 3.2)
331(17; 5.4)	332(14; 3.6)	333(25; 5.9)	334(9; 10.9)	335(6; 1.8)
336(2; 0.9)	341(4; 1.4)	342(2; 0.5)	343(5; 1.8)	347(1; 0.5)
352(2; 0.9)	353(2; 0.9)	354(4; 1.4)	356(3; 0.9)	360(2; 0.5)
361(1; *)	364(3; 0.5)	371(13; 1.4)	376(1; *)	386(44; 3.2)
387(31; 1.8)	388(18; 1.4)	389(34; 4.1)	390(39; 13.2)	391(12; 2.3)
392(10; 0.5)	393(2; 0.9)	394(9; 2.3)	395(20; 5.0)	396(6; 0.9)
397(3; 0.9)	398(2; 0.5)	399(11; 3.6)	400(20; 5.4)	401(10; 3.6)

Table 3.--Continued

Pseudopleuronectes americanus--Cont.

402(22; 6.8) 403(13; 3.2) 404(14; 5.9) 405(27; 5.4) 426(5; 2.7)
427(4; 2.7) 428(8; 3.2) 429(3; 0.9) 431(1; 0.5) 433(1; 0.5)
434(3; 1.4) 435(2; 0.9) 437(3; 0.5) 438(2; 0.5) 439(1; *)
459(9; 1.4) 460(6; 1.8) 461(7; 1.8) 462(14; 5.9) 463(3; 0.9)
464(2; 0.5) 466(1; *) 467(1; *) 470(1; *) 471(9; 3.2)
474(2; 0.5) 479(4; 0.9) 480(5; 1.8) 482(7; 1.8) 483(1; 0.5)
484(6; 2.7) 485(3; *) 489(3; *) 491(2; 0.9) 494(1; *)
496(1; *) 500(1; *) 501(17; 8.2) 502(14; 4.5) 503(9; 1.8)
504(3; 0.9) 505(26; 5.9) 506(4; 1.4) 507(18; 3.6) 508(18; 3.6)
509(12; 2.7) 510(11; 2.7) 511(4; 0.9) 512(29; 5.0) 513(3; 0.5)
516(1; 0.5) 517(9; 2.7) 518(12; 3.6) 519(2; 0.9) 520(3; 1.8)
521(1; *) 522(5; 0.9) 527(1; 0.5) 546(7; 2.3) 547(3; 0.5)
555(2; 0.5) 557(3; 0.5) 558(3; 0.9) 559(8; 1.4) 560(8; 1.8)
561(2; 0.5) 562(9; 1.4) 563(7; 0.9) 564(9; 1.8) 565(4; 0.5)
566(4; 0.9) 567(55; 5.9) 568(13; 3.2) 569(14; 3.2) 570(53; 10.0
571(10; 1.8) 572(19; 5.0) 573(15; 8.6) 574(2; 0.5) 575(1; 0.5)
576(2; 0.9) 577(4; 1.4) 578(2; 0.5) 579(16; 3.2) 580(9; 3.2)
581(16; 4.1) 582(10; 2.7) 583(22; 7.3) 584(9; 2.7) 586(1; 0.5)
588(15; 3.2) 589(31; 9.1) 590(22; 5.4) 591(3; 0.5) 592(12; 2.7)
593(26; 5.4) 594(68; 13.6) 595(7; 0.9) 622(2; 1.4) 623(7; 3.2)
624(10; 1.8) 625(32; 10.4) 626(10; 4.1) 628(20; 1.4) 629(9; 0.5)
630(5; *) 633(2; *) 636(15; 0.9) 637(26; 4.1) 638(26; 4.5)
639(9; 1.4) 640(2; *) 641(9; 1.4) 642(44; 8.6) 643(28; 5.0)
644(183; 17.2) 645(78; 16.3) 646(72; 15.9) 647(25; 6.4) 648(36; 8.6)
649(30; 6.4) 650(12; 3.6) 651(40; 10.9) 652(11; 1.8) 653(47; 37.2)
655(20; 5.0) 659(8; 3.6) 662(4; 2.3) 666(1; 0.5) 682(1; 0.5)
683(8; 1.8) 684(3; 0.5) 685(13; 1.4) 686(6; 2.3) 687(15; 5.0)
688(4; 0.9) 689(7; 0.5) 690(12; 2.3) 691(11; 5.4) 692(5; 2.3)
693(8; 4.5) 694(6; 2.3) 695(4; 2.3) 696(3; 0.9) 697(2; 0.9)
698(4; 0.9) 699(20; 7.7) 700(8; 2.3)

CYNOGLOSSIDAE

Symphurus plagiusa, blackcheek tonguefish

325(1; *) 539(1; *)

Symphurus sp.

36(1; *) 221(1; *) 421(1; *)

BALISTIDAE

Balistes capriscus, grey triggerfish

164(1; *)

Monacanthus hispidus, planehead filefish

35(1; *) 86(1; *) 87(1; *) 90(1; *) 113(1; *) 114(1; *)
117(2; *) 134(1; *) 140(2; *) 142(4; *) 143(1; *) 144(3; *)
145(4; *) 150(6; *) 151(2; *) 157(1; *) 163(9; *) 164(3; *)
166(1; *) 168(2; *) 173(1; *) 187(1; *) 200(2; *) 201(2; *)
202(5; *) 203(3; *) 204(1; *) 205(6; *) 206(2; *) 207(2; 0.5)
208(2; *) 210(2; *) 211(2; *) 212(11; *) 213(7; *) 214(3; *)
215(14; 0.5) 216(2; *) 227(2; *) 233(4; *) 235(4; *) 236(3; *)
260(1; *) 266(7; 0.5) 268(7; *) 269(1; *) 270(1; *) 271(1; *)
273(6; *) 274(7; *) 275(2; *) 276(8; *) 277(6; *) 279(2; *)
293(37; 1.4) 294(1; *) 295(8; *) 297(2; *) 298(1; *) 324(2; *)
325(3; *) 329(2; *) 330(1; *) 335(3; *) 342(3; *) 353(2; *)
354(19; 0.9)

Table 3.--Continued

T TRAODONTIDAE

Sphoeroides maculatus, northern puffer

35(1; *) 120(1; *) 137(1; *) 139(27; 0.5) 144(1; *) 198(12; 0.5)
199(5; *) 200(5; *) 201(8; 0.5) 202(7; *) 204(2; *) 206(1; *)
209(2; *) 212(15; *) 214(92; 2.7) 215(52; 0.5) 233(2; *) 234(8; 0.5)
236(2; *) 260(2; *) 261(1; *) 263(1; *) 264(2; *) 265(1; *)
266(2; *) 271(1; *) 272(10; *) 273(5; *) 274(1; *) 276(1; *)
294(2; *) 321(1; *) 322(1; *) 331(1; *) 332(6; *) 333(1; *)
334(2; *)

☆GPO 798-558

on *Delaware II* and *Albatross IV* surveys.

Albatross IV 74-2

Taxon	Average Rank	Dominance	Abundance	Frequency
rthern sand lance	4.42	30/56	0.1-33.2 (16.6)	41/56
llock	3.17	6/56	0.1-57.0 (28.5)	30/56
lantic herring	2.76	5/56	0.1-6.4 (3.2)	30/56
Atlantic cod	2.68	0	0.3-12.3 (6.1)	23/56
Haddock	1.96	0	0.1-6.0 (3.0)	13/56

Albatross IV 74-13

Taxon	Average Rank	Dominance	Abundance	Frequency
Atlantic herring	5.22	57/108	0.1-263.2 (131.6)	76/108
Pollock	3.46	10/108	0.1-57.0 (28.5)	34/108
Paralepididae	3.25	12/108	0.2-12.3 (6.2)	21/108
Silver hake	3.16	4/108	0.2-5.5 (2.8)	24/108
Atlantic cod	3.09	2/108	0.2-28.6 (14.3)	22/108
Myctophidae	2.82	1/108	0.2-3.4 (1.7)	14/108

Delaware II 74-12

Taxon	Average Rank	Dominance	Abundance	Frequency
Atlantic herring	4.51	40/56	0.3-380.0 (190.1)	50/56
lver hake	2.98	4/56	0.2-27.9 (14.0)	35/56
Fourbeard rockling	2.84	0	0.2-85.4 (42.8)	26/56
d hake	2.62	2/56	0.2-63.9 (32.0)	22/56
Witch flounder	2.06	1/56	0.2-3.4 (1.8)	19/56

Albatross IV 75-2

Taxon	Average Rank	Dominance	Abundance	Frequency
Northern sand lance	4.16	35/87	0.2-361.8 (181.0)	49/87
Pollock	3.69	21/87	0.2-25.6 (12.9)	51/87
Atlantic herring	2.73	4/87	0.2-32.2 (16.2)	38/87
Atlantic cod	2.34	0	0.2-8.8 (4.5)	28/87
Haddock	2.08	0	0.2-3.7 (1.9)	27/87

Table 3.— Station data a

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m³)	Atl. herring	Red hake	Silver hake	Myctophidae	Gulf Stream flounder	But fi
										No./100 m^3		
2	41°-35'	69°-20'	1/X	0747	128	836						
3	41 -46	68 -30	23/IX	2049	158	1096		2.9	6.7	0.1	0.1	
4	41 -49	68 -00	23	2329	62	712		62.1	48.2		0.6	
5	41 -50	67 -21	24/IX	0228	46	696	20.6	7.3	1.4			
6	41 -52	66 -45	24	0510	40	589	625.3					
7	41 -57	66 -10	24	0807	63	780	0.1					
8	42 -00	65 -30	24	1226	177	1415						
9	42 -30	65 -30	24	1500	82	710		1.4	56.2			
10	43 -00	65 -30	24	1851	98	907			0.2			
11	43 -15	65 -40	24	2306	40	548		0.2	0.4			
12	43 -30	66 -12	25/IX	0244	46	574	242.2					
13	43 -12	66 -00	25	0445	53	718	4.9					
14	43 -00	66 -00	25	0613	74	660			0.3			
15	42 -45	66 -00	25	0818	63	625			0.2			
16	43 -30	66 -00	25	1031	154	1053						
17	42 -15	66 -00	25	1316	195	1216			0.1			
18	42 -00	66 -00	25	1430	98	841			0.1			
19	41 -45	66 -00	25	1613	98	1085	0.1		0.1			
20	41 -30	66 -00	25	1749	99	1075		0.1				
21	41 -15	66 -00	25	1920	168	1405				0.3		
22	41 -00	66 -30	25	2220	122	948		0.2		0.7		
23	41 -15	66 -30	26/IX	0021	88	792	0.6		0.3			
24	41 -30	66 -30	26	0212	81	759	86.0					
25	41 -45	66 -30	26	0355	63	686	7.7					
26	42 -00	66 -30	26	0606	63	709	0.2					
27	42 -15	66 -30	26	0812	215	1219			0.2			
28	42 -30	66 -30	26	1046	191	1261			0.1			
29	42 -45	66 -30	26	1315	105	780			0.1			
30	43 -00	66 -30	26	1516	116	1061		0.1	0.1			
31	43 -15	66 -30	26	1718	53	647						
32	43 -30	66 -30	26	1909	84	822			0.6			
33	43 -46	66 -31	26	2116	85	622	143.9					
34	44 -00	66 -30	26	2316	76	609						
35	44 -25	66 -30	27/IX	0151	158	1257	0.4					
36	44 -25	67 -00	27	0425	64	732	2.2					
37	44 -00	67 -00	27	0650	123	763	17.7					
38	44 -25	67 -30	27	0925	187	1115						
39	43 -25	67 -30	27	1135	195	1279						
40	43 -00	67 -00	27	1424	118	1030						
41	43 -00	67 -00	27	1547	180	1273						
42	43 -30	67 -30	27	1814	201	1213						
43	43 -15	67 -30	27	3030	177	1134						
44	43 -15	67 -00	27	2258	128	1216			0.1			
45	43 -00	67 -00	28/IX	0044	175	1355			0.2			
46	42 -45	67 -00	28	0245	203	1455						
47	42 -30	67 -00	28	0518	191	1240		0.1	0.3			
48	42 -15	67 -00	28	0746	183	1309		0.2	1.8			
49	42 -00	67 -00	28	0944	41	582	486.1	1.2				
50	41 -45	67 -00	28	1127	40	620	76.5	1.0				
51	41 -30	67 -00	28	1325	46	632	50.8	0.9	12.2			
52	41 -15	67 -00	28	1512	50	726						
53	41 -00	67 -00	28	1706	63	708	4.8	0.7	23.7	0.1		
54	40 -45	67 -00	28	1857	84	856				63.4		
55	40 -30	67 -00	28	2041	190	1197				112.9		
56	40 -30	67 -30	28	2332	99	956			1.6	40.3		
57	40 -45	67 -30	29/IX	0122	78	739			5.8	74.3		
58	41 -00	67 -30	29	0302	61	663	0.6	0.5	11.6	15.1		
59	41 -15	67 -30	29	0453	37	621	27.2	0.6	0.6			
60	41 -31	67 -30	29	0648	41	635	2.8	0.9				
61	41 -45	67 -30	29	0838	39	510	3.9	23.5	0.6			
62	41 -56	67 -30	29	1011	59	665		43.0	6.2			
63	42 -15	67 -30	29	1224	191	1388		3.0	1.4			

bundance, *Delaware II* Cruise 71-4.

ta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m³)	Atl. herring	Red hake	Silver hake	Myctophidae	Gulf Stream flounder	Butter-fish	Window-pane
										No./100 m³			
4	42°-30'	67°-30'	29	1420	209	1538		0.3	0.4				
5	42 -30	68 -00	29	1736	178	1135		0.2	0.4				
6	2 -15	68 -00	29	1943	125	1259		0.2	0.5				
7	2 -00	68 -00	29	2200	146	1225		5.0	21.9	0.2		0.1	0.1
8	1 -50	68 -30	29	2336	47	578	1.2	25.6	23.4		0.4	0.2	1.0
0	41 -15	67 -59	30/IX	0320	45	521	23.8	0.2	1.0				10.8
1	41 -00	68 -00	30	0523	33	584	6.3		384.8		0.2		2.2
2	40 -45	68 -00	30	0711	46	756		37.6	110.2	53.0		2.7	0.1
3	0 -30	68 -00	30	0849	105	881			2.0	17.9			
4	0 -30	68 -30	30	1122	56	700			4.7	11.7			
5	0 -45	68 -30	30	1324	40	612	1.0	8.2	139.4				0.5
6	41 -02	68 -31	30	1517	35	467		11.4	1.5				4.5
7	41 -15	68 -30	30	1637	40	662	0.3	39.6	28.9		0.3	0.3	9.7
8	41 -30	68 -30	30	1758	64	752		50.5	25.1	0.1	1.6	2.1	
9	1 -45	68 -30	30	1945	125	1309		41.1	42.6			0.5	0.2
0	2 -00	68 -30	23/IX	1823	168	1047		0.2	0.9				
1	2 -15	68 -30	23	1503	142	1162		0.1					
2	42 -30	68 -30	23	1354	212	1421			0.2				
3	42 -30	69 -00	23	1115	160	1275							
4	42 -30	69 -30	23	0837	192	1352							
5	3 -00	69 -29	23	0511	106	1125							
6	3 -30	69 -30	23	0203	135	985							
7	3 -30	70 -00	22/IX	1228	108	732		0.3					
8	43 -15	70 -00	22	1030	113	973							
9	43 -00	70 -00	22	0842	104	1042							
0	43 -00	70 -15	22	0643	139	1257			1.9				
1	2 -45	70 -15	22	0447	109	903							
2	2 -45	70 -00	22	0256	158	1427							
3	2 -40	70 -00	22	0049	133	1138			0.1				
4	42 -15	69 -54	21/IX	2242	111	942		0.1	0.3				
5	42 -00	69 -00	30/IX	2306	107	961		0.1	0.3				
6	41 -45	69 -00	1/X	0044	161	1131			0.1				
7	1 -30	69 -00	1	0943	154	989							
8	1 -15	69 -00	1	1142	108	986		4.1	4.5			0.3	0.3
9	1 -00	69 -00	1	1654	61	721		26.8	130.5				0.6
0	40 -45	69 -00	1	2327	61	697		7.0	25.5	8.6	0.6		
1	40 -30	69 -00	2/X	0103	62	867		146.4	263.7	15.6	0.2		1.5
2	40 -15	69 -00	2	0247	76	799		0.6	104.6	37.3			
3	0 -15	69 -30	2	0501	59	665			9.2		0.8	0.3	
4	0 -30	69 -30	2	0644	55	660	0.2	12.9	75.8	0.2		0.8	0.5
5	0 -47	69 -26	1/X	2109	40	627		40.3	52.8		22.5	10.7	6.1
6	40 -55	69 -32	1	1950	40	603		138.8	0.3			3.3	2.7
7	41 -15	69 -25	1	1423	38	589		3.2	0.2				
8	1 -32	69 -30	1	0630	37	704							
9	1 -45	69 -30	1	0120	142	1240			0.1				
0	-35	69 -40	1	0512	35	566							
3	0 -40	70 -00	2/X	0913	41	690		10.7	23.0		5.4	0.2	
4	40 -30	70 -00	2	1027	47	671		247.2	95.1		16.7	11.9	0.3
5	40 -15	70 -00	2	1222	84	887		18.0	23.3		0.5		0.1
6	0 -00	70 -00	2	1530	151	1256		14.8	2.0	1.1	0.2	2.5	0.1
7	0 -00	70 -30	2	1708	174	1221	0.2	1.2		2.0	0.8		
8	0 -00	71 -00	2	1903	232	1155				24.7	0.3		
9	40 -30	71 -00	3/X	0040	46	659		90.1	13.6		5.6	1.1	
0	40 -30	70 -30	3	0314	55	635		5.7	6.5		1.7	0.6	
1	40 -45	70 -30	3	0502	38	658		82.1	96.7	0.2	3.8	1.7	
2	0 -45	71 -00	3	0739	42	777		79.8	112.7		54.7	3.1	
3	1 -00	71 -00	3	0937	32	550		5.8	2.4			0.2	
4	1 -00	70 -48	3	1219	34	359		1.4				0.3	0.6
5	41 -12	70 -40	3	1328	25	396		10.9				2.0	0.3
6	41 -15	71 -04	3	1513	35	518		0.2				0.2	

Table 4. Station data and larval fish

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m^3)	Atl. herring	Pollock	Myctophidae
								No./100 m^3	
1	43°-00'	65°-30'	3/XII	1936	98	440	0.5		
2	42 -45	65 -30	3	2129	85	461			
3	42 -30	65 -30	3	2315	78	336			
4	42 -15	65 -29	4/XII	0142	100	215			
5	42 -00	65 -30	4	0336	175	1052			4.4
6	41 -45	65 -30	4	0541	175	925			1.3
7	41 -30	65 -30	4	0740	180	940			
8	41 -15	65 -30	4	0955	224	979			0.3
9	41 -00	65 -30	4	1410	234	1072			0.3
10	40 -45	66 -00	4	2110	170	1165			0.5
11	41 -00	66 -00	4	2310	175	1060			0.1
12	41 -15	66 -00	5/XII	0131	175	1052			0.6
13	41 -30	66 -00	5	0410	170	785			
14	41 -45	66 -00	5	0940	76	315			
15	42 -00	66 -00	5	1150	73	453			
16	42 -15	66 -00	5	1350	150	1045			
17	42 -30	66 -00	5	1617	112	522			
18	42 -45	66 -00	5	1950	48	212			
19	43 -00	66 -00	5	2125	110	475			
21	43 -30	66 -12	6/XII	0045	55	166	9.0		
22	43 -45	66 -16	6	0212	45	253	38.3		
23	44 -00	66 -30	6	0350	50	256	50.0		
24	43 -45	66 -30	6	0508	72	207	39.6		
25	43 -25	66 -30	6	0630	67	360	0.6		
26	43 -15	66 -30	6	0750	45	245			
27	43 -00	66 -30	6	0915	90	522			
28	42 -45	66 -30	6	1100	93	525			
29	42 -30	66 -30	6	1248	175	950			
30	42 -15	66 -30	6	1441	175	1014	0.1		
31	42 -00	66 -30	6	1627	65	244	0.4		
32	41 -45	66 -30	6	1738	60	237	0.8		
33	41 -30	66 -30	6	1850	60	319	3.4		
34	41 -15	66 -30	6	2019	68	318	0.3		
35	41 -00	66 -32	6	2138	68	338			
36	40 -45	66 -30	6	2300	160	1203			2.1
37	40 -30	66 -30	7/XII	0106	93	997			1.3
38	40 -15	67 -00	7	0340	95	958			2.8
39	40 -30	67 -00	7	0526	112	1248			0.5
40	40 -45	67 -00	7	0730	85	378			0.8
41	41 -00	67 -00	7	0920	50	224	0.9		
42	41 -15	67 -00	7	1055	50	234	2.6		
43	41 -30	67 -00	7	1340	50	182	19.2		
44	41 -45	67 -00	7	1500	45	192	22.4		
45	42 -00	67 -00	7	1634	50	184	58.2		
46	42 -15	67 -00	7	1855	194	1203			
47	42 -30	67 -00	7	2115	204	1153			
48	42 -45	67 -00	7	2330	204	1207			
49	43 -00	67 -00	8/XII	0123	132	773			
50	43 -15	67 -00	8	0302	162	933			
51	43 -30	67 -00	8	0453	196	1075			
52	43 -45	67 -00	8	0715	153	941			
53	44 -00	67 -00	8	0840	128	933			
54	44 -15	66 -56	8	1022	160	885			
55	44 -15	66 -30	8	1218	41	248	0.4		
56	44 -30	66 -15	8	1340	120	506			
57	44 -30	66 -30	8	1458	130	795			
58	44 -30	67 -00	8	1705	114	374			
59	44 -26	67 -30	8	1850	53	224			
60	44 -15	67 -30	8	2010	143	952			
61	44 -00	67 -30	8	2205	175	1040			
63	43 -30	67 -30	9/XII	0116	214	1140			
65	43 -00	67 -30	9	0422	258	846	0.4		
67	42 -30	67 -30	9	0725	258	1196	0.1		
68	42 -15	67 -30	9	0910	196	1209			
69	41 -56	67 -30	9	1130	18	115	1.7		
70	41 -45	67 -30	9	1253	38	183	7.7		
71	41 -30	67 -30	9	1427	33	130	19.2		
72	41 -15	67 -25	9	1600	43	225	47.6		
73	41 -00	67 -30	9	1717	45	220	2.7		
74	40 -45	67 -30	9	1843	55	329			
75	40 -30	67 -30	9	2010	97	568			
76	40 -15	67 -30	9	2135	224	1123			1.3
78	40 -15	68 -00	10/XII	0007	214	1125			

abundance, Albatross IV Cruise 71-7.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m^3)	Atl. herring	Pollock	Myctophidae
							No./100 m^3		
79	40°-30'	68°-00'	10	0203	100	476			
80	40 -45	68 -00	10	0325	60	254	7.5		
81	41 -00	68 -00	10	0441	50	203	4.9		
82	41 -15	68 -00	10	0600	46	272	68.8		
83	41 -30	67 -55	10	0750	41	146	18.5		
84	41 -45	68 -00	10	0950	18	93	3.2		
85	42 -00	68 -00	10	1114	165	1111			
86	42 -15	68 -00	10	1253	152	869			
87	42 -30	68 -00	10	1422	152	1017			
88	43 -00	68 -00	10	1712	162	691			
89	43 -30	68 -00	10	2010	204	1116			
90	44 -00	68 -00	10	2320	90	696			
91	44 -15	68 -00	11/XII	0031	46	264	1.9		
92	44 -00	68 -30	11	0302	46	303	2.0		
93	43 -30	68 -30	11	0545	153	918			
94	43 -00	68 -30	11	0850	175	755			
95	42 -30	68 -30	11	1220	175	831			
96	42 -15	68 -30	11	1413	160	563			
97	42 -00	68 -30	11	1604	158	612			
98	41 -45	68 -30	11	1820	84	351			
99	41 -30	68 -30	11	2010	114	278	25.1		
100	41 -15	68 -30	11	2135	38	231	5.2		
101	41 -00	68 -30	11	2320	38	206	6.8		
102	40 -45	68 -30	12/XII	0045	43	244	66.0		
103	40 -30	68 -30	12	0205	55	277	1.1		
104	40 -15	68 -30	12	0352	170	966			
105	40 -00	68 -30	12	0535	175	992			
106	40 -15	69 -00	12	0935	125	787			
107	40 -30	69 -00	12	1130	47	287	1.4		
108	40 -45	69 -00	12	1300	47	265	24.5	0.8	
109	41 -00	69 -00	12	1417	55	338	10.4	2.1	
110	41 -15	69 -00	12	1530	108	615	4.6		
111	41 -30	69 -00	12	1655	120	533	0.6		
112	41 -45	69 -00	12	1830	174	565			
113	42 -00	69 -00	12	2000	174	828			
114	42 -30	69 -00	12	2333	204	1002			
115	43 -00	69 -00	13/XII	0325	100	398			
116	43 -30	69 -00	13	0605	90	514			
117	43 -45	69 -00	13	0750	80	296	0.3		
118	43 -45	69 -30	13	0950	53	241	2.5		
119	43 -30	69 -30	13	1115	125	422			
120	43 -15	69 -30	13	1305	92	607			
121	43 -00	69 -30	13	1450	120	588			
122	42 -45	69 -30	13	2135	175	747			
123	42 -30	69 -30	14/XII	0025	153	1096			
124	42 -15	69 -30	14	0238	170	905			
125	42 -30	70 -00	14	0533	170	617			
126	42 -45	70 -00	14	0720	152	680			
127	43 -00	70 -00	14	0905	83	413			
128	43 -15	70 -00	14	1149	85	607			
129	43 -30	70 -00	14	1733	80	323	0.3		
130	43 -15	70 -25	14	2005	46	221	1.8		
131	43 -00	70 -30	14	2205	33	158	3.2		
132	42 -45	70 -30	14	2338	53	244	1.2		
133	42 -30	70 -30	15/XII	0128	28	147			
134	42 -15	70 -30	15	0255	60	272	0.4		
136	42 -15	70 -00	15	0537	85	382			
137	42 -00	69 -57	15	0740	12	80	1.3		
138	42 -00	69 -45	15	0845	130	472			
139	42 -00	69 -30	15	1015	175	824			
140	41 -45	69 -30	15	1221	138	652			
141	41 -45	69 -45	15	1400	83	283	0.4		
142	41 -30	69 -35	15	1615	33	247			
143	41 -15	69 -25	15	1850	23	112			
144	40 -54	69 -14	15	2225	50	239	18.4		
145	40 -30	69 -30	16/XII	0252	47	305	1.3		
147	40 -00	69 -30	16	1050	85	447			
148	39 -47	69 -35	16	1320	170	1177			
151	40 -11	69 -54	16	0800	75	346			0.1
152	40 -05	69 -57	16	1705	47	289	4.3		
153	40 -23	70 -07	16	1900	53	219	4.5	3.1	
154	40 -34	70 -20	16	2100	47	183	6.4	10.5	
155	40 -48	70 -31	16	2300	33	174	76.5	1.1	
156	40 -58	70 -40	17/XII	0102	38	217	13.8		
157	41 -12	70 -53	17	0302	30	230	10.1		
							2.2		

Table 5. Station data and larval fi

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m^3)	Atl. herring	Atl. cod	Pollock	Silver hake	Red hake	Myctophidae	Para- lepidi
										No./100 m^3			
1	41°-14'	70°-59'	28/XI	1748	15	125	2.4						
2	41 -10	70 -40	28	1954	21	126	7.1			1.6			
3	41 -00	70 -40	28	2121	27	159	3.1			0.6			
4	41 -00	71 -00	28	2324	37	289	3.1		1.4	1.7		0.4	
5	41 -00	71 -30	29/XI	0259	48	294				2.0	0.3		
6	40 -45	71 -00	29	0529	45	263				1.5			
7	40 -30	71 -01	29	0712	53	356	0.6			5.1		0.3	0.3
8	40 -15	71 -30	29	1125	58	399				1.8	0.5		
9	39 -59	70 -59	29	1430	85	675	0.2				0.2	0.2	
10	40 -00	70 -30	29	1817	103	661						0.5	0.2
11	40 -15	70 -29	29	2022	106	679	0.6			0.2		0.2	
12	40 -15	70 -00	2/XII	2000	82	524	1.2			0.6		0.2	
13	40 -00	70 -01	2	2141	114	559				0.2			
14	40 -15	69 -31	3/XII	0120	65	417	1.7		3.6	1.9			
15	40 -15	69 -01	3	0350	84	670							
16	40 -30	69 -00	3	0633	60	379	0.5		5.0				
17	40 -29	69 -31	3	0900	47	345	0.9			2.3			
18	40 -29	70 -00	2/XII	1733	59	368	7.6		2.2	3.3			
19	40 -31	70 -31	29/XI	2208	56	313	2.6	2.2					
20	40 -46	70 -32	30/XI	0005	40	243	3.3	0.8		2.1	0.4		
21	40 -40	70 -00	2/XII	1546	35	231	33.8			0.9	0.9		
22	40 -55	69 -40	3/XII	1153	25	151	35.8						
23	40 -46	69 -32	3	1319	32	167	24.6	7.2	2.4		0.6		
24	40 -45	69 -00	3	1644	50	351	23.9	3.7		0.3			
25	41 -00	69 -00	3	1923	68	445	107.2						
26	41 -00	69 -16	3	2051	43	268	17.9	0.8					
27	41 -15	69 -21	3	2221	48	225	2.7						
28	41 -14	69 -01	4/XII	0003	95	674	2.4		0.3				
29	41 -29	69 -01	4	0241	105	684	0.9						
30	41 -30	69 -22	4	0448	57	393	0.3						
31	41 -44	69 -30	4	0619	101	686	0.3						
32	41 -44	69 -00	4	0852	106	670							
33	41 -59	68 -59	4	1125	95	714							
34	42 -15	69 -31	4	1432	102	682							
35	41 -55	69 -51	4	1747	53	392	3.7		1.0				
36	42 -15	70 -00	4	1948	88	733	1.1		0.3				
37	42 -30	70 -00	4	2217	117	629	0.2						
38	42 -44	70 -01	5/XII	0114	112	660							
39	42 -45	70 -15	5	0402	87	604	0.5						
40	42 -59	70 -15	5	1510	103	550	1.1						
41	43 -00	70 -00	5	1757	106	685							
42	43 -14	70 -00	5	1953	91	742	1.1						
43	43 -30	70 -00	5	2208	84	477	3.6						
44	43 -29	69 -32	6	0026	95	695	0.4						
44A	43 -15	68 -46	9/XII	0007	95	670							
45	43 -01	69 -30	6/XII	0327	97	648							
46	42 -30	69 -30	6	0645	101	770							
47	42 -32	68 -30	6	1108	101	679							
48	42 -16	68 -30	6	1247	108	631							
49	42 -01	68 -30	6	1438	95	700	0.3						
50	41 -46	68 -30	6/XII	1618	95	754	1.2						
51	41 -30	68 -30	6	1831	92	612	1.8			0.2			
52	41 -15	68 -31	6	2100	36	280	6.4		2.5				
53	41 -00	68 -30	6	2310	37	260	9.2	2.7		0.4	0.4		
54	40 -46	68 -29	7/XII	0127	38	212	0.9	5.2					
55	40 -30	68 -30	7	1813	40	228		0.9		0.9			
56	40 -15	68 -30	7	2007	92	762							
57	40 -15	68 -01	7	2231	90	779						0.8	0.1
58	40 -29	68 -00	8/XII	0103	103	733							0.3
59	40 -42	68 -00	8	0234	60	432		6.9					
60	41 -00	68 -00	8	0520	33	246	4.1	16.7					
61	41 -15	68 -00	8	0649	18	120	4.2	24.2					
62	41 -28	68 -09	8	0830	31	211	12.3	35.5					
63	41 -50	68 -01	8	1052	28	191		0.5	0.5				

abundance, *Albatross IV* Cruise 72-9.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Vol. Filtered (m^3)	Atl. herring	Atl. cod	Pollock	Silver hake	Red hake	Myctophidae	Para lepididae
							No./100 m^3						
64	42°-00	68°-00	8	1218	100	732	0.3						
65	42 -14	68 -02	8	1403	95	749	0.1						
66	42 -30	68 -00	8	1643	97	720	0.1						
67	42 -45	68 -00	8	1833	102	783	0.1						
68	42 -45	67 -30	10/XII	0224	93	690							
69	42 -30	67 -30	10	0414	100	759							
70	42 -15	67 -30	10	0603	95	710							
71	42 -00	67 -35	10	0746	31	209							
72	41 -44	67 -30	10	1009	27	190	1.1	6.8					
73	41 -31	67 -30	10	1153	25	194	2.1	30.9					
74	41 -16	67 -21	10	1330	30	183	13.1	27.3					
75	41 -02	67 -30	10	1501	52	412	2.9	3.6			0.2		
76	40 -45	67 -30	10	1636	77	556	0.4	9.7					
77	40 -30	67 -30	10	1806	95	791	0.1						0.8
78	40 -31	67 -00	10	2047	97	882						0.5	0.7
79	40 -45	67 -01	10	2353	87	645						0.9	4.5
80	40 -59	66 -58	11/XII	0139	66	526	1.1	1.3					
81	40 -15	67 -00	11	0409	52	434	1.6				0.2		
82	41 -29	66 -58	11	0920	53	367	25.3		7.6				
83	41 -45	67 -01	11	1130	55	364	8.5	6.0					
84	41 -59	66 -59	11	1348	43	330	4.8	3.0			0.3		
85	42 -15	67 -00	11	1605	100	689							
86	42 -29	67 -00	11	1826	103	739							
87	42 -30	66 -30	11	2146	104	708	0.1						
88	42 -15	66 -30	11	2326	88	650							
89	42 -00	66 -30	12/XII	0113	70	501	0.2						
90	41 -44	66 -30	12	0332	60	435	2.8						
91	41 -30	66 -30	12	0512	80	590	0.3		0.3				
92	41 -15	66 -30	12	0648	76	530	0.2						
93	41 -00	66 -31	12	0830	48	397						0.3	1.5
94	41 -14	60 -05	12	1109	106	751	0.1				0.1	0.7	3.1
95	41 -29	66 -00	12	1337	90	688							
96	41 -43	66 -00	12	1512	86	757	0.3						
97	42 -00	65 -30	12	1824	114	559						2.9	0.2
98	42 -00	66 -00	12	2104	68	500							
99	42 -13	66 -00	12	2220	93	784							0.3
100	42 -51	66 -30	15/XII	1807	98	696							
101	42 -28	66 -00	13/XII	0028	101	696							
102	42 -43	66 -00	13	0207	51	368							
103	42 -45	66 -30	13	0519	119	619							
104	42 -45	67 -00	13	0748	90	671							
05	43 -01	66 -58	13	0955	118	773							
105A	43 -15	67 -45	9/XII	2245	91	642							
106	43 -19	67 -00	14/XII	0310	97	725							
107	43 -29	67 -00	14	0503	102	806	0.1						
107A	43 -45	67 -45	9/XII	1853	119	735							
108	43 -45	67 -00	14/XII	0720	87	645							
09	43 -57	67 -00	14	0857	99	737							
110	44 -19	67 -29	14	1233	86	771							
111	44 -19	66 -59	14	1450	101	779							
112	44 -20	66 -40	14	1632	97	783	1.3						
113	44 -00	66 -30	14	1835	55	412	2.2						
114	43 -45	66 -30	14	1956	73	594	23.1						
115	43 -30	66 -30	14	2130	87	531	1.9	0.2					
116	43 -29	66 -17	14	2253	62	470	5.5						
117	43 -14	66 -30	15/XII	0044	68	532	7.5						
118	42 -59	66 -29	15	0249	97	720							
119	43 -00	66 -01	15	0529	93	726	1.7						
120	43 -10	66 -00	15	0645	77	499	1.0						
121	43 -14	65 -33	15	0915	33	235	1.3						
122	43 -00	65 -30	15	1648	97	771							
123	43 -10	65 -01	15	1415	106	785							
124	43 -29	65 -01	15	1205	92	722							

Table 6.— Station data and larval fis

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m³)	Atl. herring	Atl. cod	Silver hake	Pollock	Red hake	Myctophida
									No./100 m³			
1	41°-15'	71°-00'	4/XII	1225	28	202	2.0				1.0	
2	41 -15	70 -40	4	1426	14	102	2.9	13.7			2.9	
3	41 -00	70 -40	4	1649	41	231	2.2		1.3			
4	41 -00	71 -00	4	1831	35	239		0.7	0.8			
5	40 -59	71 -28	4	2130	35	239	0.4	0.4			0.4	
6	40 -45	71 -00	5/XII	0010	54	345	5.5		0.3		0.3	
7	40 -29	71 -01	5	0245	71	496	8.5	1.0	6.7		0.4	
8	40 -15	71 -30	5	0530	77	501	4.0		5.4		1.2	0.2
9	40 -01	71 -00	5	1017	95	744	0.1				0.3	0.3
9A	39 -45	71 -00	5	1205	109	814	0.1	0.1	0.2		0.5	0.1
9B	39 -45	70 -30	5	1540	113	801	2.8	0.6	3.1		0.4	
10	40 -00	70 -30	5	1840	122	915	1.1	0.1	3.2			0.1
11	40 -14	70 -30	5	2120	80	543	0.9		0.2			1.1
12	40 -15	70 -00	6/XII	0105	95	710	0.6		0.1			
13	40 -00	70 -00	6	0620	92	736	0.3					2.4
13A	39 -45	69 -59	6	1103	98	735	0.9				0.1	2.7
13B	39 -45	69 -30	6	1917	100	750						1.7
13C	39 -59	69 -30	6	2100	93	695	0.9			0.1		0.7
14	40 -13	69 -30	6	2250	74	545	0.6	0.2				
14A	40 -00	69 -00	7/XII	0149	100	807	2.5	0.4		0.1		0.7
15	40 -15	69 -00	7	0442	107	727	1.1	0.1	0.3			0.1
16	40 -30	69 -00	7	0632	68	520	33.1		0.2			
17	40 -29	69 -30	7	0942	68	558	5.7					
19	40 -30	70 -30	7	1439	62	425	21.2	8.5	1.2		0.2	
20	40 -45	70 -30	7	1621	53	350	21.4		0.6		0.6	
21	40 -45	70 -00	7	1847	30	204	81.9	7.8				
22	40 -53	69 -39	7	2100	30	216	0.5	2.8				
23	40 -45	69 -30	7	2215	47	335	129.5	2.1				
24	40 -45	69 -00	8/XII	0143	56	385	113.5	0.5	0.5			
25	41 -01	69 -01	8	0401	80	532	30.6					
26	41 -01	69 -15	8	0558	60	344	27.3	2.9				
27	41 -15	69 -25	8	0758	35	249	0.8	0.4				
28	41 -15	69 -01	8	1025	95	765	1.4					
29	41 -30	69 -00	8	1246	102	756	0.9					
30	41 -30	69 -25	8	1534	57	330	1.2					
31	41 -45	69 -30	8	1743	105	800	0.1	0.1	0.1			
32	41 -45	69 -00	11/XII	0835	63	460	7.6					
33	41 -59	68 -59	11	0600	101	752	0.3					
34	42 -15	69 -30	10/XII	1445	104	818	0.4	0.5				
35	41 -55	69 -30	8/XII	1946	73	427	0.9	0.9		8.2		
36	42 -15	69 -59	8	1135	95	742		0.4				
37	42 -30	70 -00	20/XII	0636	110	793	0.1					
37A	42 -30	70 -15	20	0805	83	615	0.3	1.3				
37B	42 -15	70 -30	20	1030	65	439				2.5		
37C	42 -00	70 -26	20	1238	35	251	2.0			10.4	0.4	
37D	41 -55	70 -21	20	1336	22	175	2.3	37.1			0.6	
38	42 -45	70 -00	20	0442	107	739	0.1					
39	42 -45	70 -15	20	0317	42	330				2.1		
40	43 -00	70 -15	20	0136	100	762						
41	43 -00	70 -00	20	0005	101	776	0.1	0.3		0.2		
45	43 -00	69 -30	19/XII	2120	110	753						
46	42 -30	69 -30	10/XII	1740	116	752	0.4					
47	42 -30	68 -30	10	2243	86	640	0.2					
48	42 -15	68 -30	11/XII	0036	95	710	0.1					
49	42 -00	68 -30	11	0328	99	826	0.1					

abundance, Albatross IV Cruise 73-9.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m^3)	Atl. herring	Atl. cod	Silver hake	Pollock	Red hake	Myctophidae
									No./100 m^3			
50	41°-45	68°-30	11	1135	107	805	8.0				0.3	
51	41 -30	68 -30	11	1432	102	590	24.2	0.2				
52	41 -15	68 -30	11	1600	48	341	4.7	1.5				
53	41 -00	68 -30	11	1730	38	206	75.7					
54	40 -45	68 -30	11	1920	42	307	310.4	0.3				
55	40 -30	68 -29	11	2105	98	770	0.3	0.1				0.3
56	40 -15	68 -30	12/XII	0028	103	775						0.5
56A	40 -00	68 -30	12	0300	120	895	0.1					1.7
57	40 -15	68 -00	12	0655	110	909						0.2
58	40 -29	68 -00	12	0905	89	660	0.3					
59	40 -45	68 -00	12	1304	62	510	1.8	0.2				0.2
60	41 -00	68 -00	12	1520	48	380	55.0					
61	41 -14	68 -00	12	1744	26	145	91.8	45.5				
62	41 -24	68 -04	12	1917	32	256	49.6	39.1				
63	41 -49	68 -02	12	2220	54	457	0.7	0.2				
64	42 -00	68 -00	13/XII	0006	106	827	0.2					
65	42 -15	68 -00	13	0228	104	766	0.3					
66	42 -30	68 -00	13	0419	104	738						
67	42 -46	68 -00	13	0715	102	770						
68	42 -45	67 -30	13	0936	95	710						
69	42 -30	67 -30	13	1230	101	765	0.1					
70	42 -15	67 -30	13	1420	100	786						
71	42 -00	67 -35	13	1610	35	239	0.4					
72	41 -45	67 -30	13	1754	42	293	28.7	28.7				
73	41 -30	67 -30	13	1920	43	339	57.8	15.9				
74	41 -15	67 -32	13	2125	40	294	338.4					
75	41 -06	67 -30	14/XII	0012	55	408	4.2	0.5				
76	40 -45	67 -30	14	0224	80	625	1.3					0.2
77	40 -30	67 -30	14	0442	99	740	0.3					
77A	40 -15	67 -30	14	2030	102	771					0.3	2.1
78	40 -30	67 -00	15/XII	0058	117	885					0.2	2.0
79	40 -45	67 -01	15	0311	102	715						0.1
80	40 -59	67 -00	15	0521	72	592	1.5	1.7				0.2
81	41 -15	67 -01	15	0745	69	404	14.6	5.2				
82	41 -30	67 -00	15	0935	67	463	45.6	0.9				
83	41 -45	67 -00	15	1348	32	215	107.0	10.7				
84	42 -00	66 -59	15	1538	48	340	28.8	32.4				
85	42 -16	66 -59	15	1847	97	725	0.1					
86	42 -29	66 -59	15	2110	116	870						
87	42 -30	66 -30	16/XII	0558	104	805	0.3					
88	42 -16	66 -30	16	0745	114	719						
89	42 -01	66 -30	16	0942	84	613	8.2	5.7				
90	41 -45	66 -30	16	1116	83	659	5.5	0.5				
91	41 -30	66 -30	16	1335	73	594	2.9	15.7				
92	41 -15	66 -31	16	1613	83	598	1.2	7.5				
93	41 -00	66 -30	16/XII	1830	107	757						
93A	40 -45	66 -30	16	2055	86	730						10.0
93B	41 -00	66 -00	17/XII	0122	113	759		0.1			0.1	3.3
94	41 -15	66 -00	17	0411	100	810						1.1
94A	41 -30	65 -30	17	0830	120	910						
95	41 -30	66 -00	17	1311	112	813	0.1	0.4				
96	41 -45	66 -00	18/XII	0103	82	605	6.0					
97	42 -00	65 -30	18	0535	97	759						
98	42 -00	66 -00	18	2316	105	819		0.1				
99	42 -15	66 -01	19/XII	0210	123	930	1.2					
101	42 -30	66 -00	19	0502	123	827	0.1					
103	42 -45	66 -30	16/XII	0315	95	798						
104	42 -46	67 -00	16	0009	97	812						

Table 7.— Station data and larval fish abundance, Albatross IV Cruise 74-2.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m³)	Atl. herring	Northern sandlance	Pollock	Atl. cod	Haddoc
							No./100 m³				
3	41°-00'	70°-40'	11/II	1930	32	208		33.2		2.4	
4	41 -00	71 -00	22/II	0437	41	247	0.8	4.9		3.6	
6	40 -45	71 -00	22	0305	48	353	0.8	10.5	39.9	2.5	1.1
16	40 -30	69 -00	21/II	1555	63	448		1.1	0.2		0.7
17	40 -30	69 -30	21	1906	53	342	0.3	14.6	0.9	12.3	
18	40 -30	70 -02	21	2129	55	400		1.0	7.5	8.3	5.0
19	40 -30	70 -30	22/II	0011	65	435		9.7	16.6	7.4	6.0
20	40 -45	70 -30	11/II	2120	43	291	3.8	6.9	57.0	2.4	0.3
21	40 -45	70 -00	12/II	0040	25	160	2.5	13.1	0.7		
22	40 -55	69 -38	12	0250	25	227	3.1	4.0	5.3		
23	40 -45	69 -30	12	0435	33	274		0.4	6.9		
24	40 -44	69 -00	12	0714	63	461	0.2	0.4	1.1		0.2
25	41 -00	69 -00	12	1058	85	630		13.8	6.8	0.8	0.2
26	41 -00	69 -16	12	1350	47	376		7.5	0.5		
27	41 -12	69 -24	12	1540	37	275		1.1			
28	41 -15	69 -00	12	1745	104	780	0.4	0.3	0.1		
29	41 -31	69 -01	12	2001	100	791	0.1	0.9	0.1		
30	41 -31	69 -25	12	2225	60	434			0.2		
32	41 -45	69 -00	13/II	0100	112	759					
49	42 -00	68 -32	13	0405	99	788	0.4				
50	41 -45	68 -29	13	0633	110	724	0.4				
51	41 -30	68 -30	13	0829	83	680	1.3	8.5	1.2		0.2
52	41 -15	68 -30	13	1008	50	441	0.2	3.9	0.7		0.9
53	41 -00	68 -30	13	1307	37	194	0.5	3.6		1.0	
54	40 -46	68 -30	13	1537	54	348	5.1	2.0			
55	40 -30	68 -30	13	1900	84	622		1.3	0.8		0.5
56	40 -15	68 -30	13	2103	98	789		0.4			
58	40 -30	68 -00	14/II	0042	97	753		0.1	0.1		0.1
59	40 -44	68 -00	14	0229	88	650	4.2	9.5		0.8	
60	41 -00	68 -00	14	0407	50	293					
61	41 -15	68 -00	14	0711	25	223	4.5	14.8		5.2	
62	41 -24	68 -02	14	1004	35	221	1.4	26.2	8.1	8.6	
63	41 -45	68 -00	15/II	0200	27	275	0.4	2.2	0.9		
64	42 -00	68 -00	15	0315	106	745					
70	42 -16	67 -30	15	0630	120	900					
71	42 -01	67 -30	15	0818	35	234	2.6	2.6	1.7		
72	41 -45	67 -30	15	1035	40	236	0.8	19.1	3.8	1.3	
73	41 -30	67 -30	15	1221	29	248	2.8	12.9	1.2	4.0	
74	41 -16	67 -31	15	1419	35	249	3.2	16.9		3.6	
75	41 -00	67 -29	15	1716	59	472	6.4	12.7		1.3	
76	40 -45	67 -30	15	2040	80	556	1.3	4.9		1.6	0.7
80	41 -00	67 -00	16/II	0011	72	479		2.7		2.9	0.6
81	41 -14	67 -00	16	0211	67	402	6.0	8.7	1.2	0.3	
83	41 -44	67 -00	16	0800	53	322		3.4	0.3	1.6	
84	42 -00	67 -00	16	1023	55	345	0.6	9.9	4.9	1.7	
85	42 -15	67 -00	16	1229	104	771	0.5				
88	42 -15	66 -25	16	1703	104	699		0.6			
89	42 -01	66 -31	16	1900	73	530	0.2	1.7	0.4		
90	41 -45	66 -30	16	2048	70	500	0.2	2.2	0.8	0.4	
91	41 -30	66 -30	16	2245	80	549			0.6	0.4	

Table 8.— Station data and larval fish abundance, Delaware II Cruise 74-12.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m^3)	Atl. herring	Fourbeard rockling	Red hake	Silver hake	Witch fld.
									No./100 m^3		
2	42°-13'	70°-14'	12/X	2236	29	206	3.9	1.5	1.0	6.5	0.5
3	42 -10	70 -27	12	2126	35	205	0.5	85.4	63.9	27.9	3.4
4	42 -15	70 -36	12	2031	45	281	0.4		1.4	0.7	
5A	42 -28	70 -23	12	1640	77	339	55.8	19.5	6.2	9.7	
5	42 -23	70 -19	8/X	--	29	149	38.3	40.3	22.8	4.7	1.3
6	42 -20	70 -30	12/X	1733	67	362	0.6	3.3	4.4	0.6	0.6
7	42 -27	70 -44	12	2003	55	412	1.9	3.6	6.1	0.7	1.7
8	42 -32	70 -37	12	1840	65	359	3.1	1.7	8.9	1.4	
9A	42 -35	70 -25	12	1507	107	428	12.4	0.5	0.2	0.7	
9	42 -41	70 -24	11/X	1134	45	233	67.4	0.4	0.9		0.4
10	42 -44	70 -23	11	1041	85	429	2.3		0.9		
11	42 -47	70 -19	8/X	2125	110	645	5.9		1.7		0.2
12	42 -49	70 -23	11/X	0947	113	549	34.2		0.2	0.2	
13	42 -52	70 -29	11	0855	110	634				0.5	
14	42 -52	70 -34	11	0800	88	481			0.2	0.4	0.8
15	42 -51	70 -41	11	0709	59	342	0.3	1.8		6.4	1.5
16	43 -00	70 -20	8/X	2300	103	413					
17	43 -04	70 -33	11/X	0530	40	343	0.3		3.8	7.6	0.3
18	43 -11	70 -16	9/X	0025	100	435	0.7	0.5		0.2	
19	43 -10	70 -24	11/X	0410	85	500	4.6		0.4	10.4	0.6
20	43 -21	70 -22	11	0246	51	278	14.0	4.7	1.1	1.4	1.1
21	43 -20	70 -16	11	0202	70	320	8.4		1.3	0.3	0.3
22	43 -19	70 -06	9/X	0202	104	618	1.0				
23	43 -25	70 -15	11/X	0115	65	380	62.9		5.5	7.4	0.8
24	43 -30	70 -07	11	0009	40	236	16.5	1.3		0.4	
25	43 -26	69 -53	9/X	0345	120	703					
26	43 -31	69 -57	10/X	2302	95	556	0.4	0.2			
27	43 -39	69 -59	10	2201	59	350	131.1	6.3		2.6	
28	43 -30	69 -39	9/X	0512	94	558	3.2	0.4		0.2	
29	43 -39	69 -44	10/X	2044	50	356	30.3	4.5		0.8	
30	43 -46	69 -42	10	1950	53	411	8.3	5.1	0.5	0.2	
31	43 -48	69 -29	10	1817	82	478	16.1	7.3	4.2	1.7	0.8
32	43 -43	69 -25	10	1722	90	417	9.1	1.4		0.5	
33	43 -37	69 -22	9/X	0710	109	583	11.8	0.3		0.2	
34	43 -39	69 -07	10/X	1336	115	456	3.7	0.4		0.2	
35	43 -46	69 -06	10	1428	90	402	22.4			0.3	
36	43 -50	69 -07	10	1330	75	407	9.8	1.7	0.5		
37	43 -45	68 -50	9/X	0955	83	607	57.7	0.3		0.8	0.3
39	43 -57	68 -42	10/X	0921	65	444	14.6			0.5	0.2
40	43 -51	68 -38	10	1043	106	620	11.3	0.8			0.3
41	43 -46	68 -37	9/X	1130	92	540	5.4			0.6	
42	43 -53	68 -22	9	1310	86	501	4.0				
43	43 -59	68 -26	10/X	0826	95	493	80.1		0.2		
44	44 -04	68 -24	10	0742	68	293	81.6	0.3	0.7	0.3	0.3
45	43 -49	68 -09	9/X	1434	40	252	5.6				
46	44 -06	68 -00	9	1528	100	577	4.0	0.2			
47	44 -13	68 -04	10/X	0432	35	269	63.6			1.1	
48	44 -19	68 -08	10	0537	45	337	77.2	0.9			
49	44 -24	67 -40	10	0150	45	360	380.0				
50	44 -20	67 -41	10/X	0227	75	369	366.7				
51	44 -15	67 -40	9/X	1738	96	612	4.9			0.3	
52	44 -21	67 -15	9	1935	95	552	2.7			0.7	
53	44 -30	67 -20	10/X	0003	47	322	169.9				
54	44 -33	67 -17	9/X	2310	70	359	205.0				
55	44 -36	67 -09	9	2226	88	518	147.3				
56	44 -28	67 -09	9	2110	50	320	30.6				

Table 9.— Station data and l

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m³)	Atl. herring	Pollock	Atl. cod	Silver hake	Paralepididae	M
										No./100 m^3		
1	41 -13'	71 -01'	4/XII	1320	35	167				0.6		
2	41 -10	70 -04	4	1645	35	140	2.4		2.9			
3	41 -00	70 -40	4	1906	49	281	1.4			0.7		
4	41 -02	71 -00	4	2153	38	245			0.8			
5	41 -01	71 -26	5/XII	0112	55	301						
6	40 -45	71 -00	5	0413	60	369	21.1			0.5		
7	40 -30	71 -00	5	0715	81	494	14.2		1.4	1.0		
8	40 -14	71 -31	5	1029	87	528				5.5	0.8	
8.1	39 -55	71 -29	5	1320	109	684					2.8	
9.1	40 -16	71 -00	5	1630	110	616	18.0	1.1		2.9	2.3	
9	39 -59	71 -00	5	1905	107	625					12.3	
10	40 -01	70 -30	5	2200	93	534	1.0			0.7	6.4	
11	40 -16	70 -30	6/XII	0056	90	525	3.4			5.5	5.5	
12	40 -16	70 -00	6	0352	90	481	14.8		0.2	2.5	0.6	
13	40 -01	70 -00	6	0629	115	667	0.1				0.7	
14	40 -15	69 -29	6	1225	80	464	0.4			5.2	0.6	
14.1	40 -01	69 -30	6	0950	113	648						
15	40 -15	69 -01	6	1548	115	515				1.6	2.7	
16	40 -30	69 -00	6	1821	75	479	41.1		0.2	0.2		
17	40 -30	69 -31	6	2124	62	349	40.1					
18	40 -30	69 -58	6	2348	75	419	86.2	4.8	3.8			
19	40 -31	70 -29	7/XII	0255	70	377	40.8	1.6		0.5		
20	40 -44	70 -31	7	0419	55	278	65.8			0.4		
21	40 -40	70 -00	7	0718	53	270	74.1	6.3				
22	40 -55	69 -39	7	0929	38	214	3.7	57.0				
23	40 -45	69 -31	7	1051	53	234	14.5	41.0	0.9			
24	40 -45	69 -00	7	1343	85	447	21.9	11.9	0.2			
25	41 -00	69 -00	7	1547	79	430	1.6	10.2				
26	41 -00	69 -16	7	1810	44	275	7.6	50.9				
27	41 -15	69 -24	7	1947	45	237	0.4	40.5				
28	41 -16	69 -02	7	2222	108	701	0.1	0.1				
29	41 -31	69 -00	8/XII	0056	100	662	0.2			0.2		
30	41 -32	69 -24	8	0355	60	296		9.1				
31	41 -45	69 -30	8	0555	115	625	0.5	0.6				
32	41 -45	69 -00	8	0914	113	635						
33	41 -59	69 -00	8	1159	113	656						
34	42 -14	69 -29	8	1556	119	614						
35	41 -55	69 -49	8	2045	72	350	8.6	1.1				
36	42 -18	70 -00	8	2354	112	663	0.8			0.2		
37	42 -28	70 -00	9/XII	0200	112	581	0.2					
38	42 -45	70 -00	9	0433	95	541	1.7					
39	42 -46	70 -15	9	0558	50	271	0.7					
40	43 -00	70 -16	9	0809	117	588	0.3					
41	42 -59	69 -59	9	0958	100	578	0.7					
42	43 -15	70 -02	9	1239	100	642	1.9					
43	43 -30	69 -59	9	1433	95	532	3.9	0.2				
44	43 -30	69 -30	9	1756	110	532	2.6					
45	43 -00	69 -30	9	2130	98	631	1.3					
46	42 -30	69 -32	10/XII	0050	100	641	0.2					
47	42 -30	68 -30	10	0555	107	577	0.2					
48	42 -15	68 -30	10/XII	0752	105	558						
49	42 -00	68 -30	10	0935	92	620	0.2					
50	41 -45	68 -31	10	1148	110	618	0.2					
51	41 -30	68 -32	10	1344	100	539	9.5	0.4				

abundance, *Albatross IV* Cruise 74-13.

St	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m^3)	Atl. herring	Pollock	Atl. cod	Silver hake	Paralepididae	Myetophidoe
									No./100 m^3			
52	41°-16'	68°-31'	10	1614	50	282	85.8	2.8	1.1			
53	41 -00	68 -30	10	1908	54	268	86.9	0.4		0.4		
54	40 -45	68 -29	10	2138	40	216	97.2			1.4		
55	40 -30	68 -30	10	2319	78	498	23.9	0.4	1.2	0.6	2.2	
56	40 -16	68 -30	11/XII	0144	79	389	3.6					
57	40 -15	68 -00	11	0626	102	631	0.2				0.6	0.5
58	40 -30	68 -00	11	0936	107	640	0.3			0.2	0.8	
59	40 -44	68 -00	11	1344	75	494						
60	41 -00	68 -00	11	1706	44	242	263.2					
61	41 -16	67 -54	11	1839	39	204	138.7		2.5			
62	41 -26	68 -06	11	1946	35	222	251.8		3.2			
63	41 -49	68 -00	11	2146	45	247	43.3	0.4	8.9			
64	42 -00	68 -00	11	2332	95	645	0.6					
65	42 -14	68 -00	12/XII	0201	95	606	0.2					
66	42 -30	68 -00	12	0445	110	595	0.2	0.2				
67	42 -45	68 -00	12	0710	100	628						
68	42 -45	67 -30	12	0932	105	588						
69	42 -29	67 -28	12	1207	100	673						
70	42 -15	67 -29	12	1527	98	552						
71	42 -00	67 -33	12	1829	38	228	3.5		2.6			
72	41 -46	67 -30	12	2051	38	196	49.0	20.4	28.6			
73	41 -30	67 -29	12	2227	41	210	32.4	1.9	13.8			
74	41 -14	67 -29	13/XII	1245	35	253	105.1					
75	40 -58	67 -28	13	0258	62	373	201.9	0.3	1.2	0.3		
76	40 -45	67 -31	13	0419	80	476	25.0		0.6	0.8	1.3	
77	40 -30	67 -31	13	0646	95	571	0.2	0.4		0.2	1.2	0.2
77	40 -16	67 -30	13	0952	104	653					0.6	
78	40 -29	66 -59	13	1440	100	556					0.9	
79	40 -44	67 -00	13	1745	110	501	1.2	0.2				
80	41 -00	67 -00	13	2003	73	384	62.8	2.6	6.8			
81	41 -16	66 -59	13	2214	65	331	81.0	1.2	3.3			
82	41 -30	67 -01	14/XII	0014	64	353	34.0					
83	41 -43	66 -58	14	0206	59	332	63.6	0.3	3.0			
84	42 -00	67 -01	14	0504	68	398	1.8	1.0	1.8			
85	42 -15	67 -00	14	0741	97	642	0.1					
86	42 -30	67 -00	14	1039	104	563						
87	42 -30	66 -31	15/XII	1440	104	528						
88	42 -16	66 -29	15	1923	97	579						
89	42 -00	66 -30	15	2238	85	409	0.5					
90	41 -47	66 -30	16/XII	0112	83	446	1.3					
91	41 -31	66 -30	16	0355	93	495	6.3	1.0				
92	41 -15	66 -31	16	0614	90	516	6.8					
93	41 -00	66 -30	16	0828	95	584		0.2			0.2	0.2
94	41 -15	66 -01	16	1340	98	538					0.2	0.4
95	41 -29	66 -00	16	1755	98	516					0.2	
96	41 -44	66 -01	16	2135	95	559					0.4	
99	42 -14	65 -58	17/XII	1119	105	654	0.2	0.2				
101	42 -29	65 -59	17	1441	98	632						
103	42 -45	66 -30	17	1952	98	624		0.2		0.2	0.3	
104	42 -46	67 -01	17	2320	98	529						
125	42 -59	67 -29	18/XII	0325	98	526						
130	43 -00	68 -00	18	0642	105	550						
131	43 -00	68 -30	18	1015	105	515	0.2					
135	42 -59	69 -00	18	1604	98	577	0.2					

Table 10.—Station data and larval fis

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m^3)	Northern sandlance	Pollock	Atl. cod	Atl. herring	Haddock
									No./100 m^3		
3	41°-00'	70°-40'	27/II	0839	55	303	13.2		1.3	2.0	
4	41 -00	70 -59	27/II	1130	62	280	2.9			0.4	
5	41 -00	71 -20	28/II	0400	47	197	3.6			0.5	
5.1	40 -45	71 -30	28	0219	59	312	4.2				
5.2	40 -30	71 -30	28	0019	22	135	11.1	5.2		0.7	0.7
6	40 -46	71 -00	27/II	1313	58	345	3.5	0.6	1.5	0.4	
7	40 -30	71 -01	27	1518	75	472	38.8	3.4			0.4
8	40 -15	71 -30	27	2155	75	472	2.8	1.1			0.2
8.1	40 -00	71 -30	27	2022	90	619	4.2	0.3	0.2		0.5
9.1	40 -15	71 -00	27	1700	92	593	5.4	1.4	0.2		1.2
10	40 -00	70 -30	26/II	2133	100	666	0.6				
11	40 -15	70 -31	27/II	0042	95	633	28.0	2.7	1.1		0.6
12	40 -15	70 -00	26/II	0222	100	559	2.3	7.2			0.7
13	40 -00	70 -00	26	0515	97	602		0.3			
14	40 -15	69 -30	25/II	0846	62	504	2.4	10.3	1.6		0.6
14.1	40 -00	69 -29	25	0644	90	551					
15	40 -15	69 -00	24/II	0246	93	641	2.8	3.1	0.3	0.2	0.2
16	40 -30	69 -00	25/II	0101	62	381	12.3	3.4	0.8	1.3	0.5
17	40 -30	69 -30	25	1037	70	343	23.0	15.7	8.2		1.5
18	40 -30	70 -00	25	2240	59	324	71.9	25.6	6.2	0.6	3.7
19	40 -30	70 -30	27/II	0252	67	427	51.8	1.2	1.9		0.5
20	40 -45	70 -30	27	0544	52	282	9.2	1.4		4.3	
21	40 -40	70 -00	25/II	2002	41	240	44.2		0.4	9.2	
22	40 -54	69 -40	25	1450	42	206	12.6	2.9	1.9		
23	40 -45	69 -30	25	1233	42	243	10.7	18.9	0.8	0.4	0.4
24	40 -45	69 -00	24/II	2258	64	369	11.6	1.6	2.2	2.7	1.1
25	41 -00	69 -00	24	2027	67	407	24.1	7.4	1.0	0.2	0.7
26	41 -00	69 -17	24	1832	45	236	41.5	18.2		0.4	0.4
27	41 -15	69 -25	24	1543	42	204	2.0	4.4	0.5		
28	41 -15	68 -60	24	1333	98	559	11.3	1.6			
29	41 -30	69 -00	24	1050	96	664		0.5		0.2	
30	41 -30	69 -24	24	0904	66	339		1.5			
31	41 -44	69 -30	24	0706	105	629		0.2			
32	41 -45	69 -00	24	0400	85	699					
33	42 -00	69 -01	15/II	1744	108	694					
34	42 -15	69 -29	15	1409	25	150					
35	41 -56	69 -50	15	1120	21	377		2.1			
36	42 -18	70 -00	15	0815	103	473		0.2			
47	42 -13	68 -30	16/II	1440	108	755					
48	42 -15	68 -30	15/II	2135	105	725					
50	41 -45	68 -29	24/II	0212	90	659				0.2	
51	41 -30	68 -30	24	0010	93	692	1.0			0.4	
52	41 -15	68 -30	23/II	2236	45	278	4.3	0.7		0.7	0.4
53	41 -00	68 -30	23	2113	47	329	20.4		5.2	1.5	1.5

abundance, *Albatross IV* Cruise 75-2.

Sta.	Lat.	Long.	Date	Local Time	Sample Depth (m)	Volume Filtered (m^3)	Northern sandlance	Pollock	Atl. cod	Atl. herring	Haddock
									No./100 m^3		
54	40°-45'	68°-30'	23	1917	53	289	80.3	0.7	0.4	32.2	
55	40 -30	68 -30	23	1714	30	183	237.2	0.6	0.6	1.1	0.6
56	40 -15	68 -30	23	1521	98	651	0.2	3.1	0.6		0.6
58	40 -31	67 -59	23	1130	95	573					
59	40 -45	67 -59	23	1002	71	467	16.1	3.4	6.0		0.9
60	41 -00	68 -00	23	0808	53	216	181.5	6.9	6.5	9.3	
61	41 -16	67 -53	23/II	0618	25	160	361.8		8.8	21.2	
62	41 -25	68 -06	19/II	1820	25	156	59.0	0.6	6.4	27.6	
63	41 -50	67 -60	19	1523	43	292				0.3	
64	42 -00	68 -00	19	1357	95	698					
65	42 -15	67 -60	19	1116	112	700					
66	42 -30	68 -00	16/II	0249	110	629					
69	42 -30	67 -32	16	0607	108	728					
70	42 -15	67 -30	19/II	0857	89	713					
71	42 -00	67 -34	19	0705	28	277	4.7				
72	41 -45	67 -30	19	0505	36	286	12.6	9.4	3.5	0.7	
73	41 -30	67 -30	19	0445	34	221	10.4	2.7	2.7	3.2	
74	41 -15	67 -30	19	0222	35	226	10.2		0.4	22.1	
75	41 -00	67 -31	19	0054	48	447	27.7	4.5		10.7	0.2
76	40 -45	67 -30	18/II	2317	75	553		15.2			2.2
77	40 -31	67 -31	18	2141	85	742					
79A	40 -44	67 -01	18	1809	36	260					
79B	40 -46	67 -02	18	1822	79	662					
80	41 -01	67 -01	18	1515	60	338		4.4		0.6	
81	41 -15	67 -01	18	1254	67	362	3.9	20.2		0.8	3.6
82	41 -30	67 -00	18	1025	58	331	15.7	2.7		0.3	0.6
83	41 -45	66 -60	18	0819	55	320	16.2	4.7			
84	41 -59	67 -00	18	0632	59	337	17.5	1.8			
85	42 -15	67 -01	18	0333	100	628	6.8			0.2	
86	42 -30	67 -00	16	0826	105	658					
87	42 -30	66 -31	16	1250	120	618				0.2	
88	42 -15	66 -31	18	0008	95	669	0.4	0.3			0.2
89	41 -60	66 -30	17	2152	85	419	2.2	2.9		0.5	0.2
90	41 -45	66 -30	17	2001	90	390	2.0	4.6		0.5	
91	41 -30	66 -30	17	1821	83	577	0.4	10.6		0.7	
92	41 -15	66 -31	17	1534	85	574					
93	41 -00	66 -31	17	1302	100	652					
95	41 -30	66 -00	17	0825	103	669		0.5		0.2	
96	41 -45	66 -00	17	0613	98	624		0.3		0.3	
97	42 -00	65 -31	17	0138	105	675					
98	42 -00	65 -60	16	2200	105	635		0.9			
99	42 -15	66 -00	16	1910	120	652					
101	42 -30	66 -00	16	1630	115	679		0.2			

Table 11.— Length frequencies, *Delaware II* Cruise 71-4 and *Albatross IV* Cruise 71-7.

	Delaware II 71-4						*Albatross IV* 71-7	
Standard Length(mm)	Silver hake	Atl. herring	Red hake	Window-pane	Gulf Stream fld.	Butter-fish	Atl. herring	Pollock
2	1162		1594	80	132	44		
3	2553		2553	187	280	78		3
4	4903		2772	385	141	75		10
5	3336	412	1043	278	77	50		9
6	1302	1149	547	108	71	21	1	10
7	598	3047	326	54	61	3		6
8	250	2156	169	35	37	9	2	2
9	157	830	168	7	14	7	8	
10	85	1095	81	15	12	14	19	2
11	77	397	58	1	12	4	16	1
12	62	380	23	13	1	3	34	
13	4	357	47	1			58	
14	16	389	38		1		65	
15	14	381	20	4	2		64	
16	4	184	18			4	143	
17	7	65	8				255	
18	2	49	2				281	
19	3	12	15	3			253	
20	47	2	19				173	
21	45	8	2				124	
22	5	16	2				66	
23			1				39	
24	11	1	2				27	
25		1					7	
26							2	
27	9		2			1	4	
28	1						2	
29	1						1	
30						4	3	
31							1	
32	1							
33	1							
34							1	
35								
36							1	
Total	14656	10931	9510	1171	841	317	1650	43

Table 12.— Length frequencies, *Albatross IV* Cruises 72-9 and 73-91

	Albatross IV 72-9					*Albatross IV* 73-91				
Standard Length(mm)	Atl. herring	Atl. cod	Pollock	Silver hake	Red hake	Atl. herring	Atl. cod	Silver hake	Pollock	Red hake
2		69	7	2	1		101	1	1	
3		253	27	6			398	9	47	3
4	10	102	27	7	2	9	207	16	28	12
5	12	30	15	22	2	113	87	41	4	3
6	20	6	11	26		179	50	31		1
7	9	2	6	12		103	13	17	1	3
8	7	1	1	7	1	113	5	4		2
9	13	1		1		123	1	4		
10	33		1	1	2	102	1	7	2	1
11	118		1	1		86		1		1
12	158			1	1	156		1		3
13	109					211		2		1
14	77					256	1			2
15	78					435				1
16	123				1	697				
17	134					609				
18	130				1	612		2		1
19	117				1	516				
20	96					716				
21	87				1	486				1
22	67					319		1		
23	52					153				1
24	21					68				
25	18					10				
26	15					14				1
27	5					11				
28	5					12				
29	2					9				
30	1					2				
31	2									
32	2									
33						2				
34	1									
Total	1522	464	96	86	13	6123	864	137	83	37

Table 13.– Length frequencies, *Albatross IV* Cruise 74-2 and *Delaware II* Cruise 74-12.

	Albatross IV 74-2					*Delaware II* 74-12				
Standard Length(mm)	Northern sand lance	Pollock	Atl. herring	Atl. cod	Haddock	Atl. herring	Fourbeard rockling	Red hake	Silver hake	Witch flounder
2				3			94	8	20	
3	1	25		59	7		270	143	89	2
4	18	152		93	33	9	112	123	118	6
5	51	162	1	61	16	100	8	50	49	8
6	71	95	1	17	10	663		16	22	7
7	66	55		7	4	2561	1	5	8	2
8	78	51		5		1663	2	1	5	5
9	102	27		2	1	312	2	4	1	2
10	120	10	2	1		456		3	3	5
11	71	4		1	1	439			3	6
12	59	1				352		1		2
13	63	1	1			440		1	2	
14	51					456				1
15	51		1			249	1			
16	37		5			111		1	1	
17	22		13			122			1	
18	18		7			176			1	
19	9		11			174			1	
20	24		17			153	1		3	
21	8		21			51			1	
22	9		29			44				
23	10		14			30				
24	5		37			21				
25	3		29			11	1			
26	3		25			7	1		1	
27	4		14			1				
28	5		16							
29	5		16							
30	4		12							1
31	2		1							
32	2		2							1
33			4							
34	1									1
35	1									
36										1
37										
38										1
Total	974	583	279	249	72	8601	493	356	329	51

Table 14.— Length frequencies, Albatross IV Cruises 74-13 and 75-2.

	Albatross IV 74-13				Albatross IV 75-2				
Standard Length(mm)	Atl. herring	Pollock	Atl. cod	Silver hake	Northern sand lance	Pollock	Atl. cod	Atl. herring	Haddock
2		25	2	7		1	5		
3		346	129	18	1	92	88		12
4		241	84	26	6	222	203		54
5		60	10	16	14	193	87		33
6	10	27	2	21	67	175	43		11
7	8	12		16	137	99	14		10
8	11	11	1	5	193	59	3		4
9	54	1		7	308	26			1
10	204			7	488	27	2		1
11	418	1		5	468	11	2		
12	595	2		7	391	9	1		
13	687			4	387	9	1		
14	732	1		5	244	1			
15	665	1		2	203	2			
16	516			3	144	1		2	
17	480				101			2	
18	513				88	1		1	
19	513				63			3	
20	387			1	74			1	
21	290				31	1		10	
22	201				24			17	
23	110				28			25	
24	84				16			41	
25	52				7			37	
26	17			1	6			53	
27	27				5			37	
28	4				4			46	
29	8				2			37	
30	4							35	
31					1			22	
32								8	
33	1							8	
34								6	
35								5	
36									
37									
38									
39									
40									
41								1	
Total	6591	728	228	134	3501	929	449	397	126

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NOAA Technical Report NMFS SSRF- 718

Surface Currents as Determined by Drift Card Releases Over the Continental Shelf Off Central and Southern California

James L. Squire, Jr.

December 1977

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary
National Oceanic and Atmospheric Administration
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National Marine Fisheries Service
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Surface Currents as Determined by Drift Card Releases Over the Continental Shelf Off Central and Southern California

JAMES L. SQUIRE, Jr.[1]

ABSTRACT

During March 1964 through February 1966, 8,320 plastic drift cards were released at selected points from an aircraft to measure surface current drift over two areas: from the coast to about 48 n.mi. off central California between Point Arena and Point Sur; and from the coast to about 90 n.mi. off southern California between Point Arguello and Punta Salsipuedes, Baja California, Mexico. The recovery rate was 3.5% in the central area and 5.7% in the southern area. An average 79.4% of the recoveries were found within 2 wk following the date of release. Results lend support to studies concluded by earlier investigators. The distribution of the directions from which drift cards were returned increased the evidence for the presence of an eddy off the coast between San Francisco and Monterey Bay during May through July, and of the large gyre and associated southern California countercurrent south of Point Conception during April through August and to a lesser extent in October and December.

INTRODUCTION

spersal and survival of the planktonic eggs and larvae of marine fishes in the ocean euphotic zone is affected by surface currents. The purpose of this study wa to develop additional information on the drift pa erns to which surface planktonic forms are subjected over the continental shelf of the west coast of the United St es. The general direction of surface drift was determi ed and is compared with wind velocity during the su vey period to expose any general relationship between wind direction and inshore surface currents. Johnson and Sc re (1970) published the results found along the no hwestern coast of the United States. This paper covers the central area from Point Arena to Point Sur, Calif., and the southern area from Point Arguello, Calif., to unta Salsipuedes, Baja California, Mexico.

eld work for the study was carried out concurrently with an airborne infrared sea surface temperature survey of the continental shelf conducted with the cooperation of he U.S. Coast Guard (Squire 1971).

creased interest in coastal surface currents as they may pertain to the drift of surface pollutants, such as pe oleum, has prompted the documentation of this drift st y.

METHODS

lbot (1964) showed that specially prepared drift bottles could be successfully dropped from an aircraft; however, drift cards were chosen for this study due to the ease of handling and the limited space available in the aircraft. The individual drift cards are identical to those described by Johnson and Squire (1970) and were a 4 × 5¼-in, numbered, postage paid, self-addressed, fluorescent red postcard. A plain fluorescent red card was used as backing, and both were sealed in a clear plastic envelope with a steel washer as ballast. This study was conducted from March 1964 through February 1966, during which period 16 drift card releases were made off southern California and central California. From March 1964 through February 1965, airborne releases of drift cards were made once each 3 mo. Beginning in March 1965 and continuing until the end of the study, the frequency of drift card releases increased to one per month. Ten cards were released at each drop station.

The U.S. Coast Guard aircraft were flown at an average altitude of 500 ft over a prescribed pattern covering the central area to about 48 n.mi. offshore and the southern area to about 90 n.mi. offshore. Twenty-five release stations were located on the flight transects over the central area, and 27 release stations over the southern area. Dead-reckoning techniques, aided by the aircraft's tacan, loran, and radar navigation equipment were used to locate release points.

For visual comparison of wind direction, average wind speed, and the direction of surface drift, a wind rose symbol developed by Tabata (1961) was used on each drift chart (Figs. 1, 2). The symbols give the percent frequencies for the prevailing winds and calms (wind velocity 1 kn) based on eight points of the compass and the average wind speed in knots for a 2-wk period—1 wk before release and 1 wk after (drift cards were released on the last day of the first week of the 2-wk period). Wind data were obtained for geographical locations as near the

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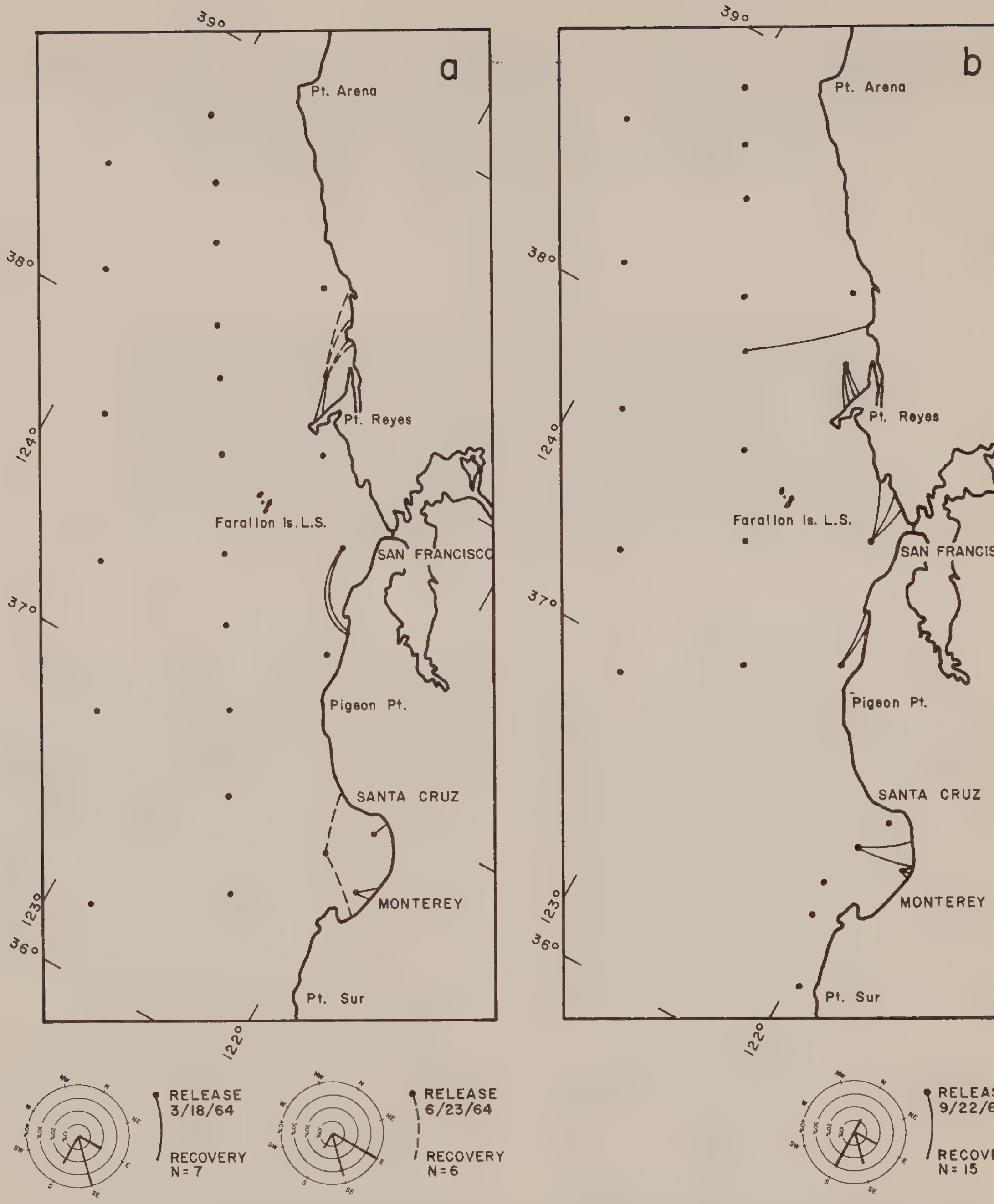

a
b
39°
38°
37°
36°
124°
123°
122°
Pt. Arena
Pt. Reyes
Farallon Is. L.S.
SAN FRANCISCO
Pigeon Pt.
SANTA CRUZ
MONTEREY
Pt. Sur
RELEASE
3/18/64
RECOVERY
N=7
RELEASE
6/23/64
RECOVERY
N=6
RELEAS
9/22/6
RECOVE
N= 15
N
NE
E
SE
S
SW
W
NW
10%
20%
30%
40%

Figure 1.—Drift card release and recovery points off the central area of California: a) March and June 1964; b) September 196 December 1964 and March 1965; d) April and May 1965; e) June and July 1965; f) August and September 1965; g) October and Nover 1965; h) December 1965 and February 1966.

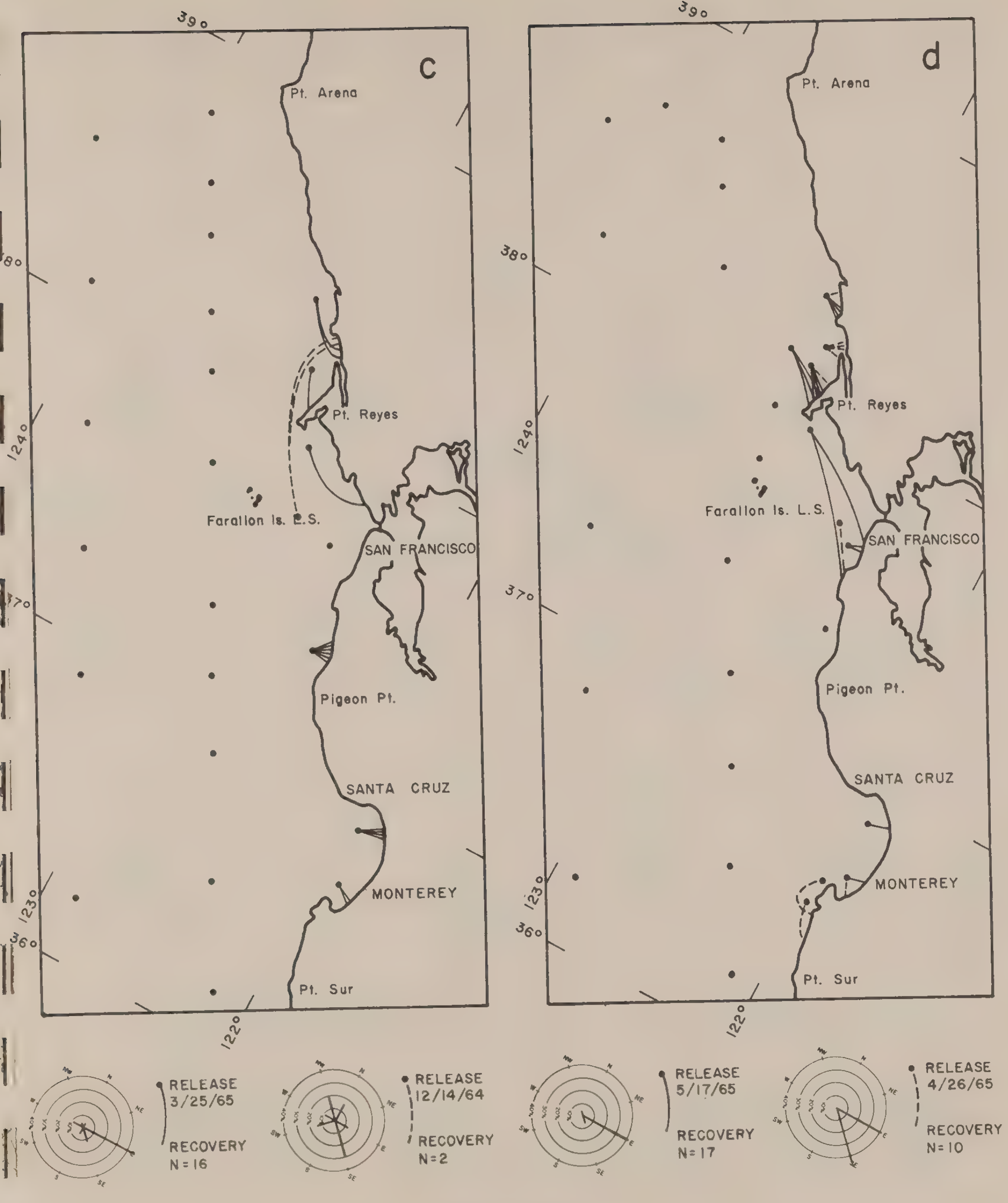

39°
c
Pt. Arena
38°
Pt. Reyes
124°
Farallon Is. L.S.
SAN FRANCISCO
37°
Pigeon Pt.
SANTA CRUZ
MONTEREY
123°
36°
Pt. Sur
122°
39°
d
Pt. Arena
38°
Pt. Reyes
124°
Farallon Is. L.S.
SAN FRANCISCO
37°
Pigeon Pt.
SANTA CRUZ
MONTEREY
123°
36°
Pt. Sur
122°
RELEASE 3/25/65
RECOVERY N=16
RELEASE 12/14/64
RECOVERY N=2
RELEASE 5/17/65
RECOVERY N=17
RELEASE 4/26/65
RECOVERY N=10

Figure 1.—Continued.

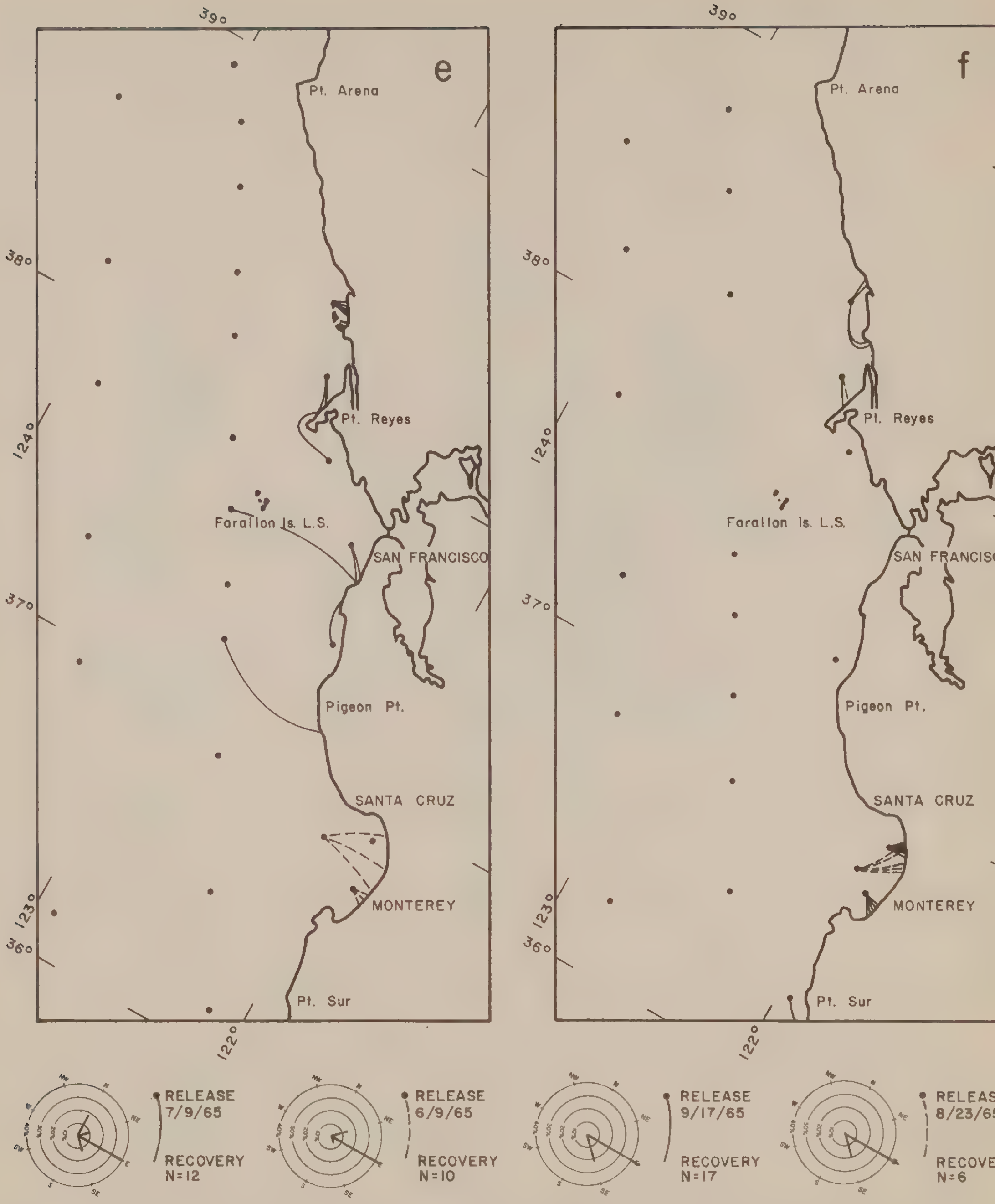
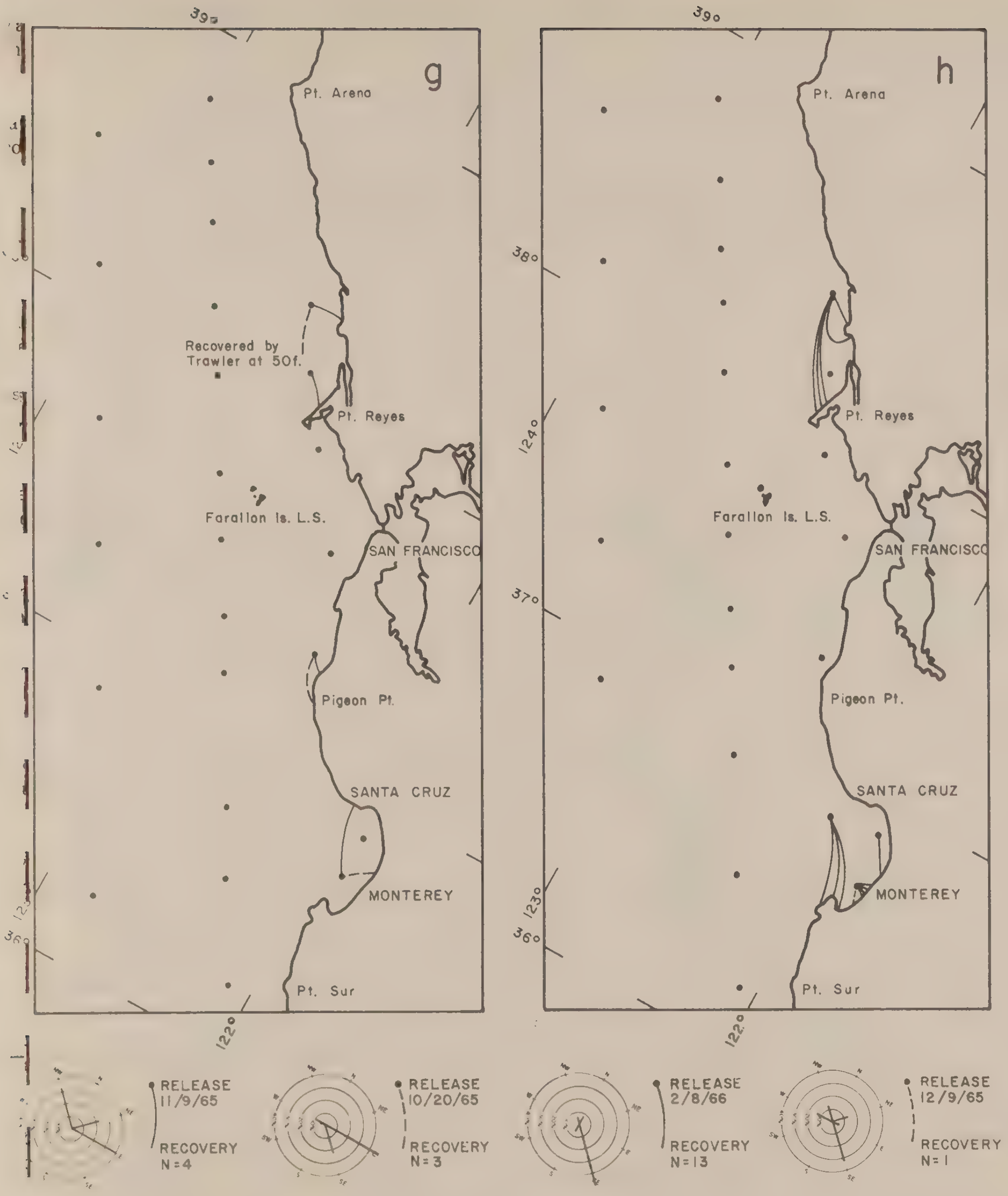

39°
e
Pt. Arena
38°
Pt. Reyes
124°
Farallon Is. L.S.
SAN FRANCISCO
37°
Pigeon Pt.
SANTA CRUZ
MONTEREY
123°
36°
Pt. Sur
122°
39°
f
Pt. Arena
38°
Pt. Reyes
124°
Farallon Is. L.S.
SAN FRANCISC
37°
Pigeon Pt.
SANTA CRUZ
MONTEREY
123°
36°
Pt. Sur
122°
NW
N
NE
E
SE
S
SW
W
10%
20%
30%
40%
RELEASE 7/9/65
RECOVERY N=12
RELEASE 6/9/65
RECOVERY N=10
RELEASE 9/17/65
RECOVERY N=17
RELEAS
8/23/6
RECOVE
N=6

Figure 1.—Continued.



39°
g
Pt. Arena
Recovered by
Trawler at 50f.
Pt. Reyes
Farallon Is. L.S.
SAN FRANCISCO
Pigeon Pt.
SANTA CRUZ
MONTEREY
Pt. Sur
36°
123°
122°
124°
38°
37°
h
RELEASE
11/9/65
RECOVERY
N=4
RELEASE
10/20/65
RECOVERY
N=3
RELEASE
2/8/66
RECOVERY
N=13
RELEASE
12/9/65
RECOVERY
N=1

Figure 1.—Continued.

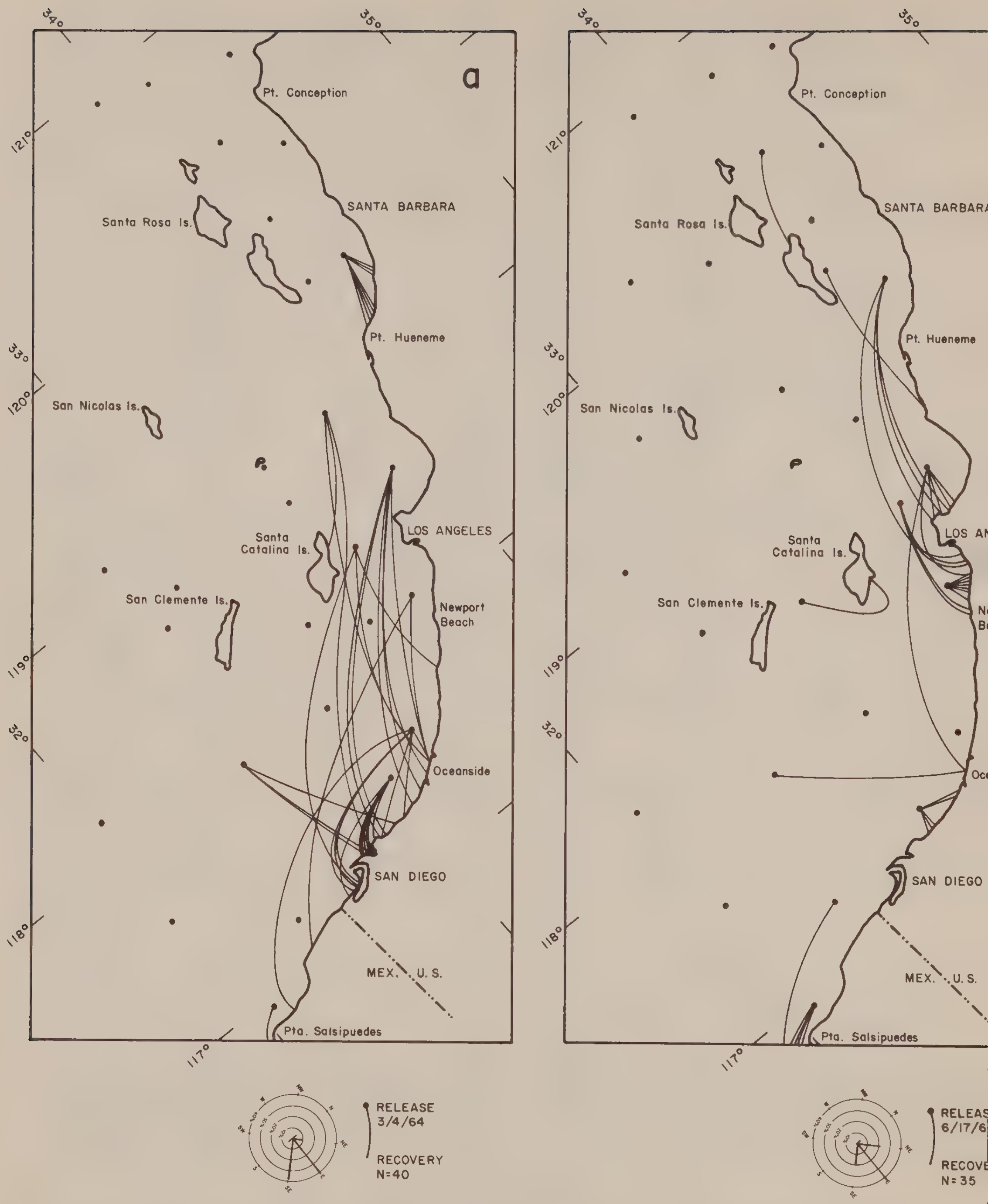

34°
35°
121°
33°
120°
119°
32°
118°
117°
a
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
San Clemente Is.
Newport Beach
Oceanside
SAN DIEGO
MEX.
U.S.
Pta. Salsipuedes
RELEASE 3/4/64
RECOVERY N=40
RELEAS 6/17/6
RECOVE N=35

Figure 2.—Drift card release and recovery points off southern California: a) March 1964; b) June 1964; c) October and December 1964; 1965; e) April 1965; f) May 1965; g) June 1965; i) August 1965; j) September and October 1965.

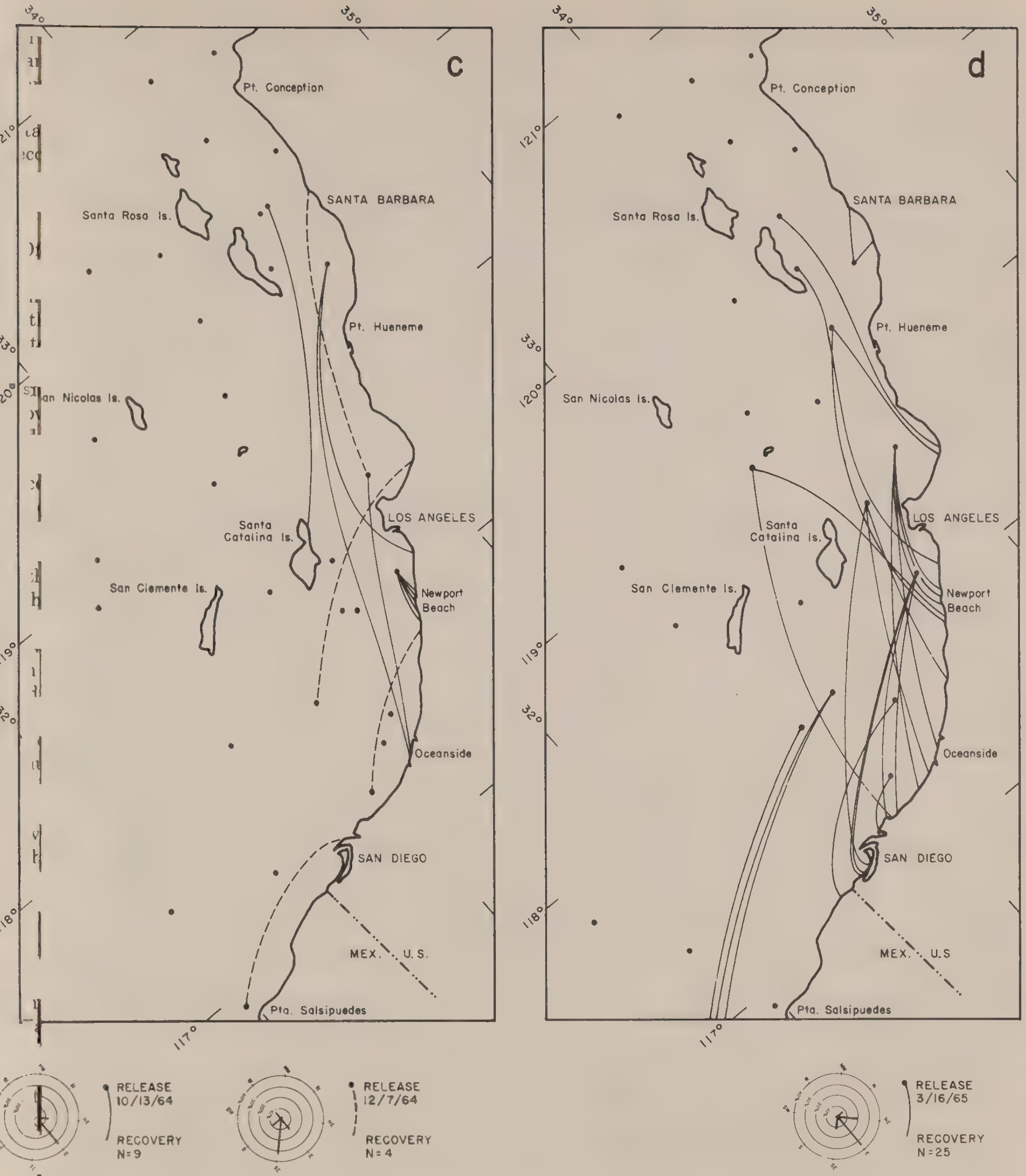

c
34°
35°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
San Clemente Is.
Newport Beach
Oceanside
SAN DIEGO
MEX. U.S.
Pta. Salsipuedes
117°
RELEASE 10/13/64
RECOVERY N=9
RELEASE 12/7/64
RECOVERY N=4
d
34°
35°
121°
33°
120°
119°
32°
118°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
San Clemente Is.
Newport Beach
Oceanside
SAN DIEGO
MEX. U.S
Pta. Salsipuedes
117°
RELEASE 3/16/65
RECOVERY N=25

Figure 2.—Continued.

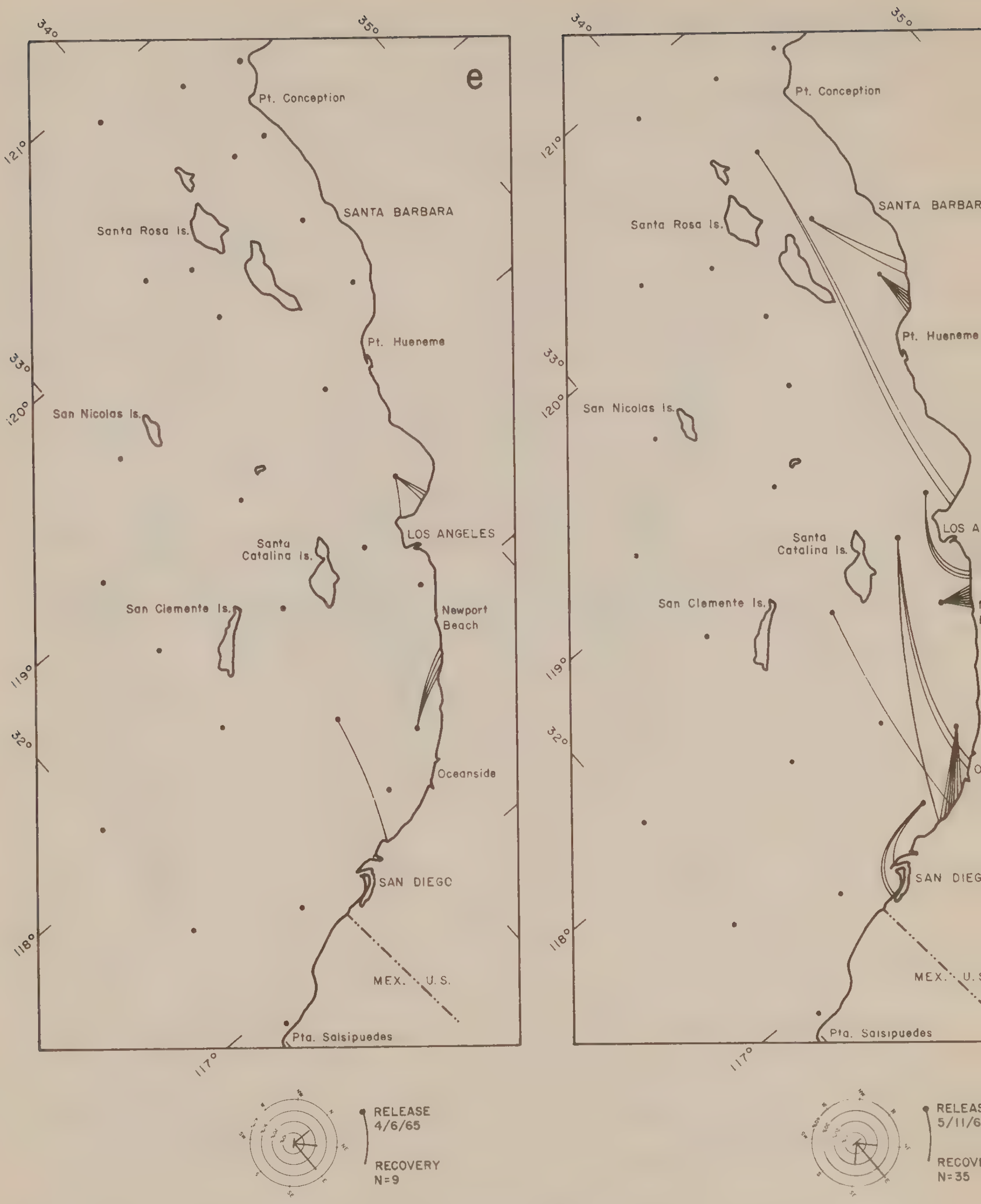

e
34°
35°
121°
33°
120°
119°
32°
118°
117°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
LOS ANGELES
Santa Catalina Is.
San Clemente Is.
Newport Beach
Oceanside
SAN DIEGO
MEX. U.S.
Pta. Salsipuedes
RELEASE 4/6/65
RECOVERY N=9
34°
35°
121°
33°
120°
119°
32°
118°
117°
Pt. Conception
SANTA BARBAR
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
LOS A
Santa Catalina Is.
San Clemente Is.
SAN DIEG
MEX. U.S
Pta. Salsipuedes
RELEAS
5/11/6
RECOVE
N=35

Figure 2.—Continued.

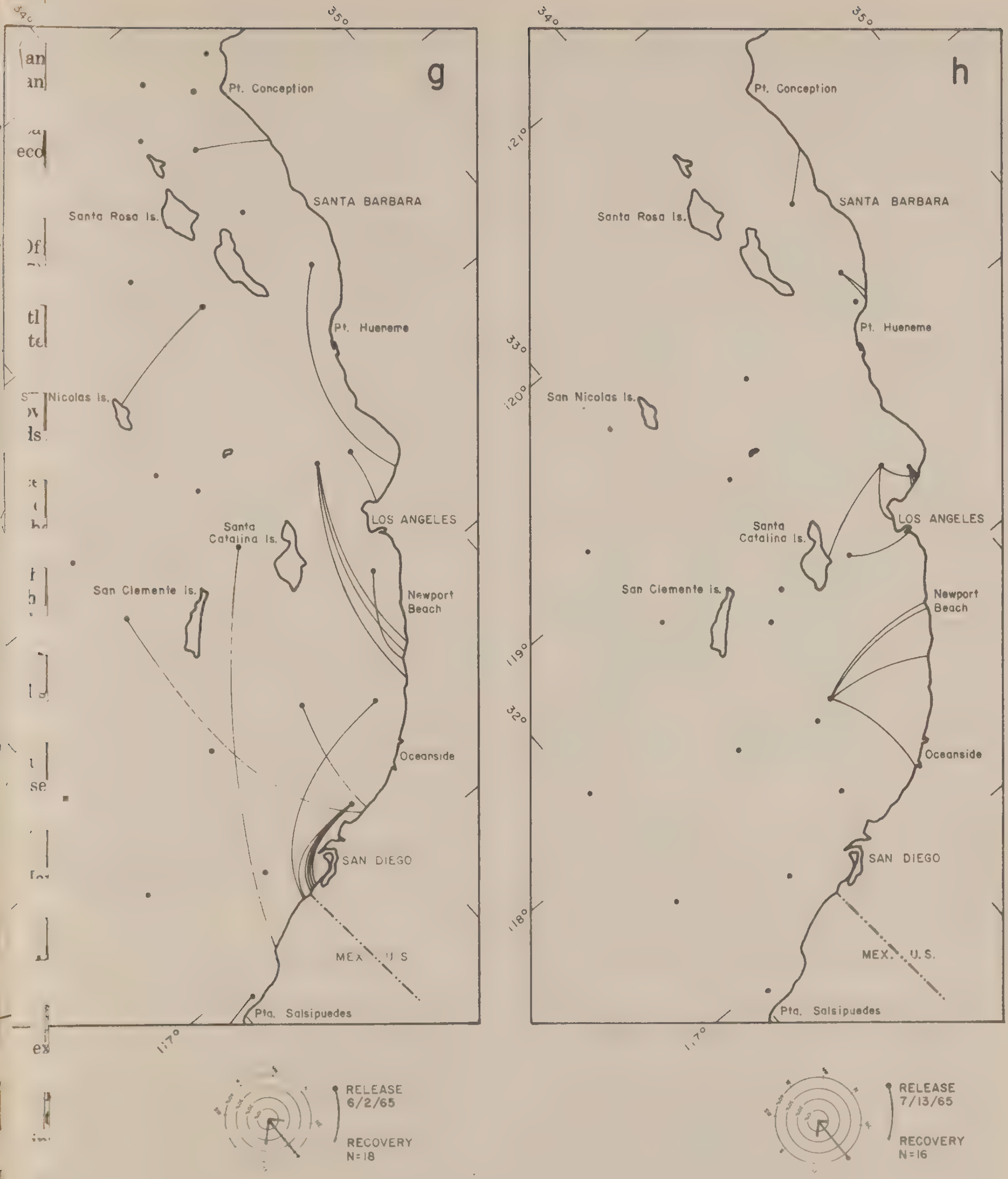
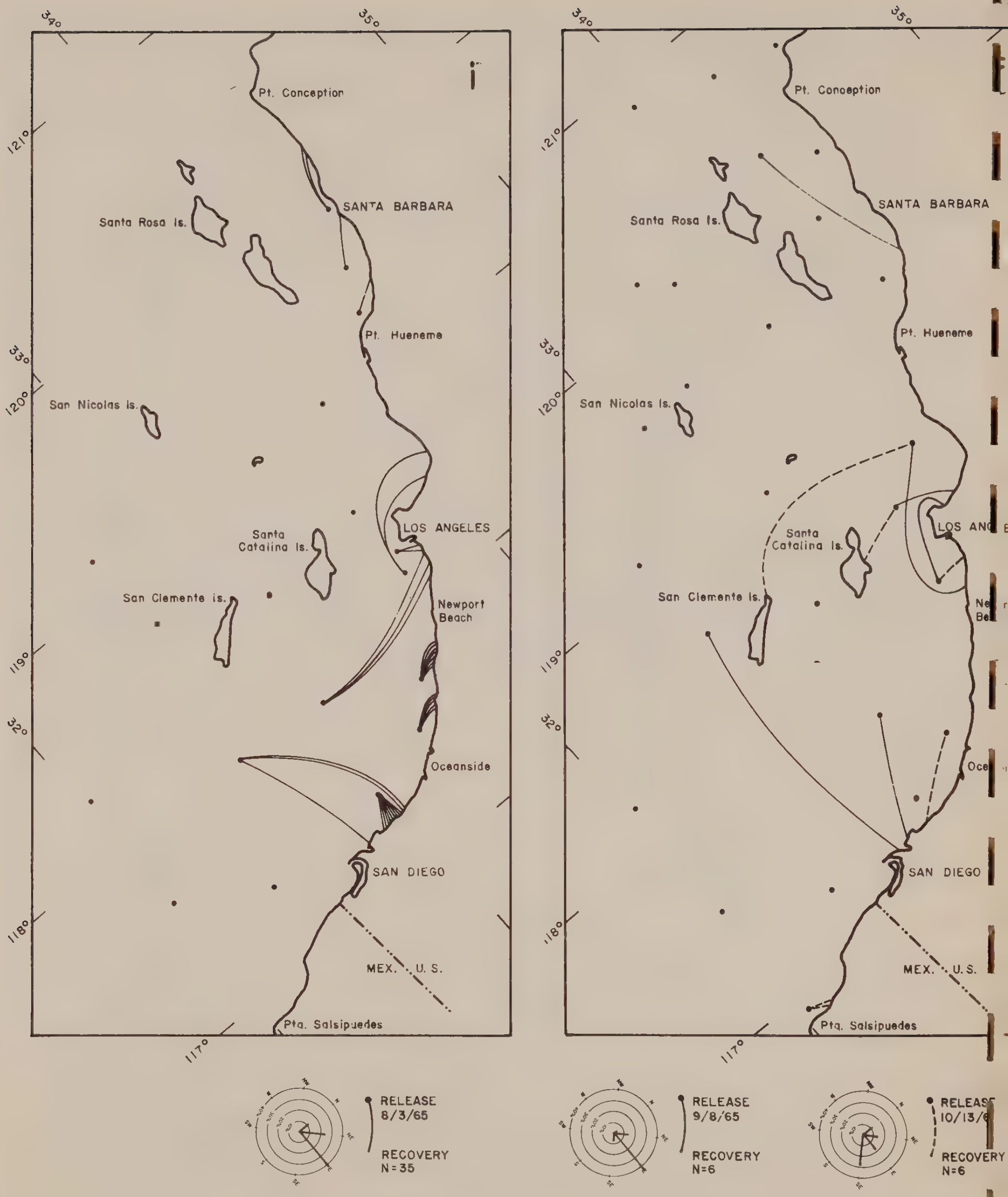

g
34°
35°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
Newport Beach
San Clemente Is.
Oceanside
SAN DIEGO
MEX. U.S.
Pta. Salsipuedes
117°
RELEASE 6/2/65
RECOVERY N=18
h
34°
35°
121°
33°
120°
119°
32°
118°
117°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
Newport Beach
San Clemente Is.
Oceanside
SAN DIEGO
MEX. U.S.
Pta. Salsipuedes
RELEASE 7/13/65
RECOVERY N=16

Figure 2.—Continued.


34°
35°
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117°
Pt. Conception
SANTA BARBARA
Santa Rosa Is.
Pt. Hueneme
San Nicolas Is.
Santa Catalina Is.
LOS ANGELES
San Clemente Is.
Newport Beach
Oceanside
SAN DIEGO
MEX.
U. S.
Pta. Salsipuedes
RELEASE 8/3/65
RECOVERY N=35
RELEASE 9/8/65
RECOVERY N=6
RELEAS
10/13/6
RECOVERY N=6

Figure 2.—Continued.

enter of each survey area as possible. Data for the central a a was obtained for the U.S. Coast Guard Farallon slan Light Station, 28 mi west of the entrance to San rancisco Bay, and in the southern area for the U.S. avy San Clemente Island Naval Air Station. These ata vere made available by the National Weather eco s Center, Asheville, N.C.

RESULTS

Of e 8,320 cards released over both study areas, 4.5% 377) were recovered. This recovery rate compares closely ith hose found by previous investigators using drift ottl and drift cards along the west coast of the United tates (Tibby 1939; Schwartzlose 1964) and near Hawaii Barkley et al. 1964). In the central area, 3.5% of the ard vere returned, whereas 5.7% of the cards were eco ed in the southern area. An average 59.8% of all ards recovered were found within 1 wk following the ate of release, and 79.4% were found within 2 wk. The erce age of recoveries made during the first week after he op in the central area was 72.1%, and in the outhern area 52.7%. By the end of 2 wk, the percentage f recoveries in the central area was 86.8% and in the out n area 75.1%.

Ch ts (Fig. 1a to 1h central area, Fig. 2a to 2j outhern area) giving the date and location of release and ecov y and the average wind velocity were prepared for ach arterly and monthly drifter releases. The average ind speed was derived by averaging all values recorded uring the 2-wk period. The rate of drift and trajectory of he rd cannot be determined from the recoveries eca e of the lack of information between time of elease and recovery. Original data to determine the time etween release and recovery is not available. No ecov ies were made and no charts were drawn for out n area releases in November and December 1965 nd January and February 1966; nor for the central area uring January 1966.

DISCUSSION AND CONCLUSIONS

Th patterns of current flow associated with the California Current along the North American west coast have een examined by a number of scientists (e.g., Tibby 939; Sverdrup et al. 1942; Reid et al. 1958; Burt and Vyat 1964; Schwartzlose 1964; Tully 1964). We would xpe the surface drift in the nearshore areas generally be in agreement with the findings of these scientists.

Drift card recovery rates probably bear a relationship th mount of shore activity by people. Many areas of e c st in the central area are rocky and not easily ccessible. This, and the fact that the coastal population sm l, would account for reduced returns when compare vith southern California. The southern California oast is easily accessible, except for the island areas, and ere is a high population level along most of the coast nd f m this a higher recovery rate would be expected.

M of the recoveries in the central area were from rop stations relatively close to shore. Only three recoveries were from the line of drop stations located about 25 mi offshore, and none were recovered from the outer line of stations, about 50 mi offshore.

Southern California recoveries were mostly from stations near the coast, between the coast and Catalina, and the Santa Barbara Channel Islands; few recoveries were from the offshore drop stations.

Drift cards recovered along the coasts of central and southern California gave evidence of some surface drift toward the east and/or southeast through most of the year. Only in December 1966 did neither area have at least one return from either direction. Five of the 15 mo in the central area and 6 of the 12 mo in the southern area had a significantly greater proportion of the recoveries from the east and/or southeast than from all other directions combined.

Off the central area, little evidence of a strong Davidson Current can be observed along the open coast during the late fall, winter, or early spring months [Fig. 1a, 1c (March), 1g (November), 1h (December, February)]. Only in December 1964 (Fig. 1c) does evidence of the coastal countercurrent exist, with recoveries from off Bodega Bay from drift cards dropped near the San Francisco light vessel. Schwartzlose (1964) had indications from his work that an eddy flowed counterclockwise during the summer between San Francisco and the north edge of Monterey Bay. In July 1965 (Fig. 1e), off Halfmoon Bay and south of Point Reyes, some of the recoveries indicated a northward flowing coastal current during this period. During the remainder of the year, most of the recoveries showed drift to the east and/or southeast.

In the southern area between Point Conception and northern Baja California, an average 69% of the drift cards recovered had moved in an east and/or southeast direction. These observations reflect the combined influence of northwest winds and the relatively permanent southerly flowing current reported by Schwartzlose (1964) off the southern California and Baja California coasts.

Evidence for the gyre south off southern California was found during the late spring and summer (Fig. 2b, 2e, 2h, 2i). Some of the returns from coastal areas were recovered northeast to northwest of release points and these recoveries were most evident along the coast from San Diego northward and offshore to the San Clemente and Catalina Islands and the Los Angeles area. During these months Tibby (1939) reported that south flowing offshore currents return along shore as the north flowing Southern California Countercurrent. Forty percent of the returns from the August 1965 (Fig. 2i) releases drifted north or northwest nearly 90° from the prevailing winds flowing toward the east-northeast. Returns from the December 1964 (Fig. 2c) drift cards lend support to the conclusion by Reid et al. (1958), that the northerly flowing countercurrent associated with the large eddy off southern California is present in some measure through the late fall and winter.

ACKNOWLEDGMENTS

I thank Stuart N. Luttich, Gerald B. Talbot, and Sven I. Johnson for assistance in the study and to express appreciation to the U.S. Coast Guard Air Stations at San Francisco and San Diego, Calif., whose cooperation helped make this study possible.

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☆ U. S. GOVERNMENT PRINTING OFFICE: 1978—799-425/6 REGION 10

NOAA Technical Report NMFS SSRF-717

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John B. Colton, Jr. and Ruth R. Byron

November 1977

U.S. DEPARTMENT OF COMMERCE
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Gulf of Maine-Georges Bank Ichthyoplankton Collected on ICNAF Larval Herring Surveys September 1971-February 1975

JOHN B. COLTON, JR. and RUTH R. BYRON[1]

ABSTRACT

The families, genera, and species of all larval fishes are tabulated and the abundance, length frequencies, and distribution of 12 species and 2 families are summarized utilizing data collected on 8 ichthyoplankton surveys of the Gulf of Maine-Georges Bank area. The segregation of coastal and oceanic species north and south of the coastal/slope water boundary during December is evidenced in a comparison of the distribution of upper 100-m integrated temperature and Atlantic herring, Myctophidae, and Paralepididae larvae. All larval barracudinas and lanternfishes occurred in areas where the integrated temperature was above 11° and 13°C, respectively. Ninety-one percent of positive larval herring tows were in areas where the integrated temperature was below 13°C.

INTRODUCTION

n 1971 the International Commission for the North-st Atlantic Fisheries (ICNAF) inaugurated a series of perative surveys of larval Atlantic herring, *Clupea engus harengus* L., in the Gulf of Maine-Georges nk area. The objectives of these surveys were to limit the major herring spawning grounds and to ob-n relative estimates of spawning stock size and infor-tion on larval drift and dispersal (International Com-ssion for the Northwest Atlantic Fisheries 1971, 1972). ese surveys, incorporating standardized sampling thods and stations, have been continued annually ce inception. Vessels from six countries have par-ipated, and 28 full-scale surveys have been completed of June 1976. In addition, a number of supplementary stal cruises of more limited scope have been under-ken in connection with this study.

In this paper we present summaries of the abundance, gth frequencies, and distribution of the more abun-nt larval fishes collected on eight cruises by U.S. ves-ls from September 1971 to February 1975. The data ere based on 61-cm, 0.505 mm-mesh bongo net samples lected on the following cruises:

Cruise No.	*Date*	*No. stations*
laware II 71-4	22 Sept.-3 Oct. 1971	122
atross IV 71-7	3-17 Dec. 1971	148
lbatross IV 72-9	28 Nov.-15 Dec. 1972	127
lbatross IV 73-9	4-20 Dec. 1973	113
batross IV 74-2	11-22 Feb. 1974	56
laware II 74-12	8-12 Oct. 1974	56
atross IV 74-13	4-18 Dec. 1974	108
lbatross IV 75-2	15-28 Feb. 1975	87

FIELD AND LABORATORY METHODS

Stations were made sequentially on a standardized grid pattern (International Commission for the Northwest Atlantic Fisheries 1972). At each station a 3.5-knot (6.5-km/h), double-oblique tow was made using paired 61-cm bongo samplers (Posgay and Marak in press) fitted with 0.505-mm and 0.333-mm nylon mesh nets. The sampler accessories (flowmeter, time-depth recorder, towing wire, and wire depressor) were rigged from specifications described by Posgay and Marak (in press). On *Delaware II* Cruise 71-4, the maximum depth of tow was 200 m or approximately 5 m off the bottom. The net was deployed at 50 m/min and retrieved at 20 m/min to 40-m depth. The upper 40 m of the water column was sampled in 20, 2-m intertal steps of 1-min duration. On *Albatross IV* Cruise 71-7 the sampling procedure was similar except that the net was retrieved continuously at 10 m/min from 40 m to the surface. On all other cruises the maximum depth of tow was 100 m or approximately 5 m off the bottom, and the net was deployed at 50 m/min and retrieved at 10 m/min. Pertinent station data for the eight cruises are listed in Tables 3-10.

All samples were processed at the Northeast Fisheries Center, Narragansett Laboratory, National Marine Fisheries Service, NOAA. Fish larvae were sorted from the total 0.505-mm mesh samples and the larvae from each sample enumerated by species or to the lowest taxa possible. For samples having less than 100 of a species, all larvae were measured to the nearest 0.1-mm standard length. The larvae were later combined into 1-mm and 3-mm size groups. In samples containing more than 100 larvae of a species, a subsample of at least 100 specimens was taken for length measurements and the total length frequency for that species determined by multiplying the number at each length interval by the reciprocal of the aliquot fraction.

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[1] Northeast Fisheries Center, Narragansett Laboratory, National Mar-e Fisheries Service, NOAA, Narragansett, RI 02882.

The flowmeter readings for each tow were converted to m^3 of water filtered. These values for a given cruise were then plotted against maximum tow depth. Obvious discrepancies in volume values caused by windmilling, etc., were corrected on the basis of average tow depth-volume filtered values. Numbers of larvae per unit volume and numbers under a unit surface area were then determined for each tow.

ICHTHYOPLANKTON SUMMARIES

The families, genera, and species of larval fishes identified on each cruise are summarized in Table 1. The families are arranged in phylogenetic order (based on Greenwood et al. 1966) and the genera listed in alphabetical order. Often the specific identity of larvae could not be ascertained and separation was made only to the generic or family level. This was most often the case for oceanic specimens collected in slope water along the edge of the continental shelf. Because of seasonal and annual differences in the species composition and abundance of larvae, the same taxa were not enumerated for each cruise. We have summarized the abundance, length frequencies, and distribution of larvae on an individual cruise basis and have included only the dominant taxa (Table 2) and species of commercial interest which occurred in at least 5% of the total stations occupied. Larvae of 12 species of fishes are included in this summary, as well as 2 familial groupings:

- CLUPEIDAE (herrings)
  - *Clupea harengus harengus* - Atlantic herring
- GADIDAE (codfishes and hakes)
  - *Gadus morhua* - Atlantic cod
  - *Melanogrammus aeglefinus* - Haddock
  - *Merluccius bilinearis* - Silver hake
  - *Pollachius virens* - Pollock
  - *Rhinonemus cimbrius* - Fourbeard rockling
  - *Urophycis chuss* - Red hake
- AMMODYTIDAE (sand lances)
  - *Ammodytes dubius* - Northern sand lance
- STROMATEIDAE (butterfishes)
  - *Peprilus triacanthus* - Butterfish
- BOTHIDAE (lefteye flounders)
  - *Citharichthys arctifrons* - Gulf Stream flounder
  - *Scophthalmus aquosus* - Windowpane
- PLEURONECTIDAE (righteye flounders)
  - *Glyptocephalus cynoglossus* - Witch flounder
- MYCTOPHIDAE (lanternfishes)
- PARALEPIDIDAE (barracudinas)

Statistics for individual taxa were calculated for each cruise using the dominance-frequency method of Fager and McGowan (1963). These statistics are summarized in Table 2. The abundance (no./100 m^3) of species and families for individual cruises and stations are listed in Tables 3-10. The species length frequencies for individual cruises are given in Tables 11-14. The distributions (no./10 m^2) of species and families are shown in Figures 1-8. The no./100 m^3 values listed in Tables can be converted to no./10 m^2 by multiplying t values by $d/10$, where d is the sample depth.

DISCUSSION

A conspicuous and significant aspect of the larval distribution is the almost total segregation of co (boreal) and oceanic (tropical and subtropical) sp north and south of the 100-m isobath during the De ber surveys. This divergence coincided with the loca of the coastal/slope water boundary (thermal f which is manifest in the surface layer (upper 10 along the edge of the continental shelf during No ber-January (Colton and Stoddard 1972). In late w and spring, the surface thermal front is located fu (approximately 20 km) offshore (Wright 1976), oceanic, vertebrate and invertebrate indicator speci not occur along the edge of the shelf (Colton 1961; ton et al. 1962). In late summer and early fall when water temperatures are maximum, the surface the front is no longer present (Colton and Stoddard 1 and oceanic indicator species are frequently found Georges Bank and contiguous areas (Figure 1; C 1961; Colton et al. 1962).

To illustrate the relationship of temperature to th tribution of coastal and oceanic larval fish species d December, we determined integrated temperatures maximum depth of 100 m, or to the bottom in sh areas, using *Albatross IV* Cruise 74-13 expendable b thermograph values at standard depths of 0, 10, 2 50, 75, and 100 m. The distribution of these integ temperatures and a plot of the abundance of larva lantic herring, Myctophidae, and Paralepididae v integrated temperature values are shown in Figure larval barracudinas and lanternfishes were collect areas where the integrated temperature was abov and 13°C respectively. Ninety-one percent of the po larval herring tows were made in areas where th tegrated temperature was below 13°C and 80% c positive tows were below 11°C.

We do not imply that the observed distribution terns of larval fishes are controlled directly by perature. Laboratory experiments have shown the lethal temperature (and salinity) for early stage herring to be appreciably higher than the tempera salinity values characteristic of slope water (B 1960; Holliday and Blaxter 1960). There are marke ferences in abundance, species composition and sp diversity of zooplankton between coastal and water. The mean standing crop is greater in coastal and the number of species greater in slope water (C 1940; Grice and Hart 1962). It is possible, therefore the distribution of coastal fish species, such as herr more contingent on biological factors (availabil suitable zooplankton forage organisms) than on the sical characteristics of their environment. Hope when additional data from these cruises have processed, we will be able to elucidate the bioti factors controlling seasonal and annual variations ribution and abundance of coastal and oceanic lar- hes.[2]

ACKNOWLEDGMENTS

larval fishes used in this study were sorted and fied by the staff of the Ichthyoplankton Inves- on, Northeast Fisheries Center Narragansett atory, National Marine Fisheries Service, NOAA. hank Susan Senerchia for the initial tabulation of uise data, Alice DeNofa and Dorothy Shavers for the tables, and Lianne Armstrong for preparing gures.

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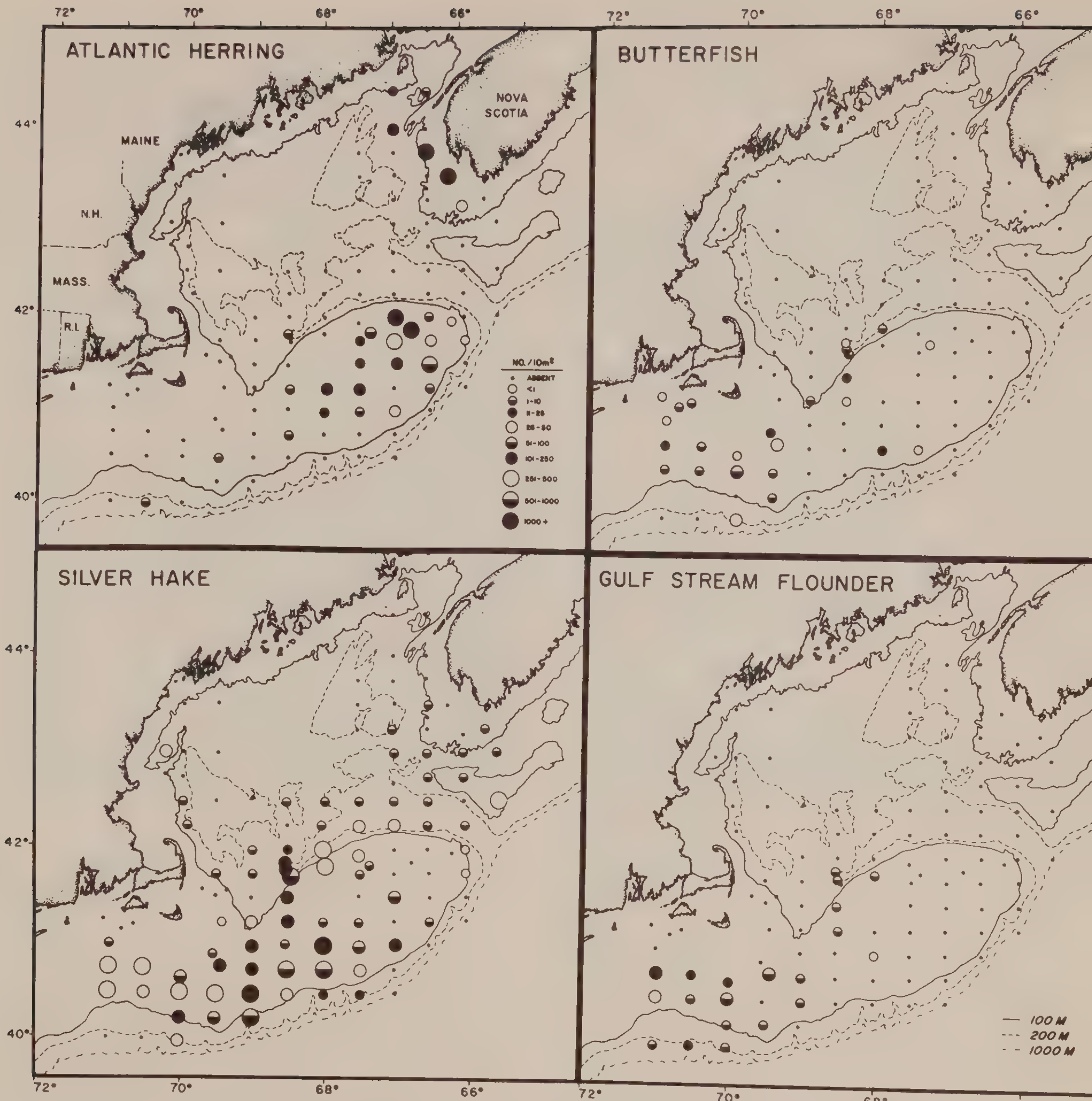
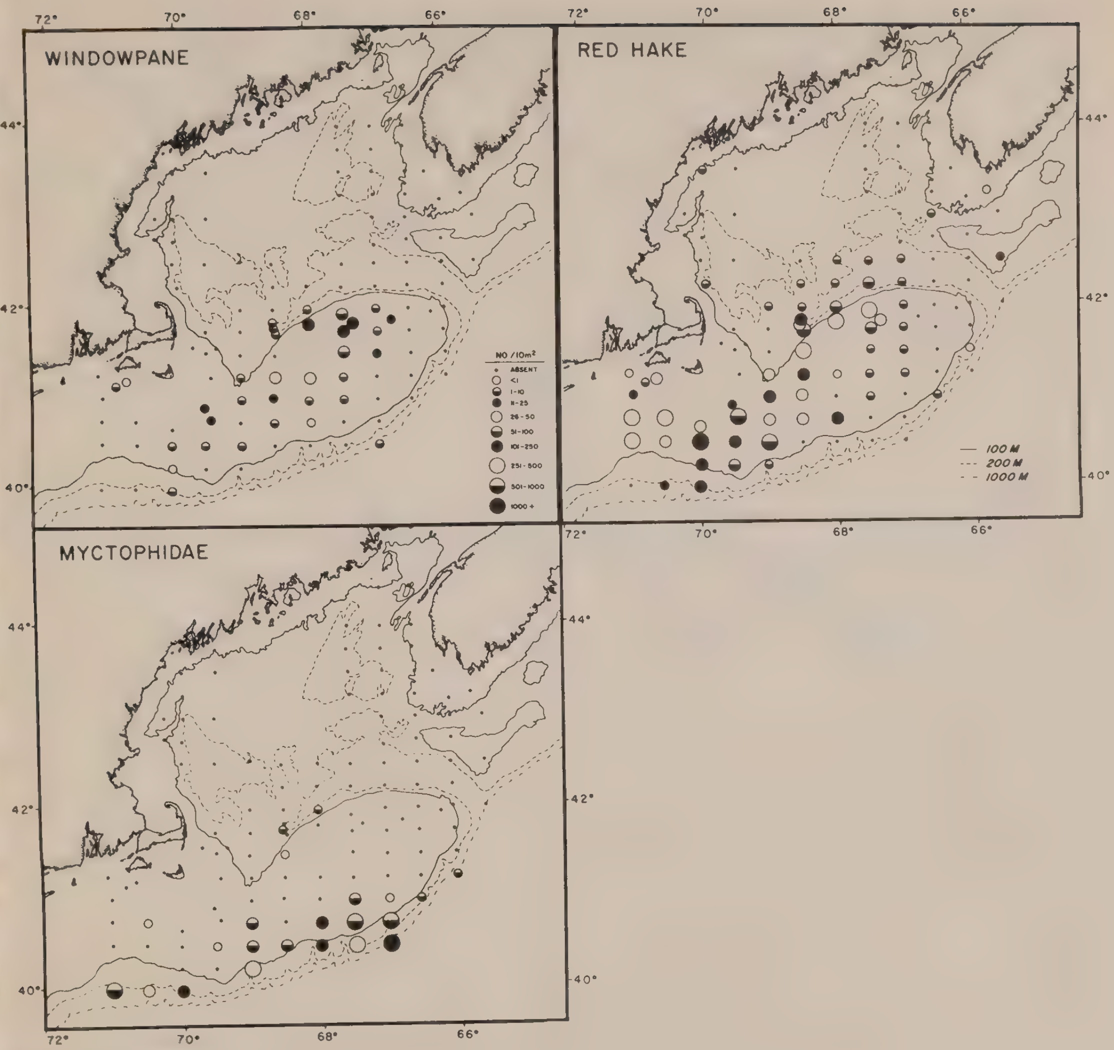


ATLANTIC HERRING
BUTTERFISH
SILVER HAKE
GULF STREAM FLOUNDER
MAINE
N.H.
MASS.
R.I.
NOVA SCOTIA
72°
70°
68°
66°
44°
42°
40°
NO. / 10m²
ABSENT
<1
1-10
11-25
26-50
51-100
101-250
251-500
501-1000
1000 +
100 M
200 M
1000 M

Figure 1.—Larval fish distribution, *Delaware II* Cruise 71-4, 22 September-3 October 1971.


WINDOWPANE
RED HAKE
MYCTOPHIDAE
NO /10m²
• ABSENT
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72°
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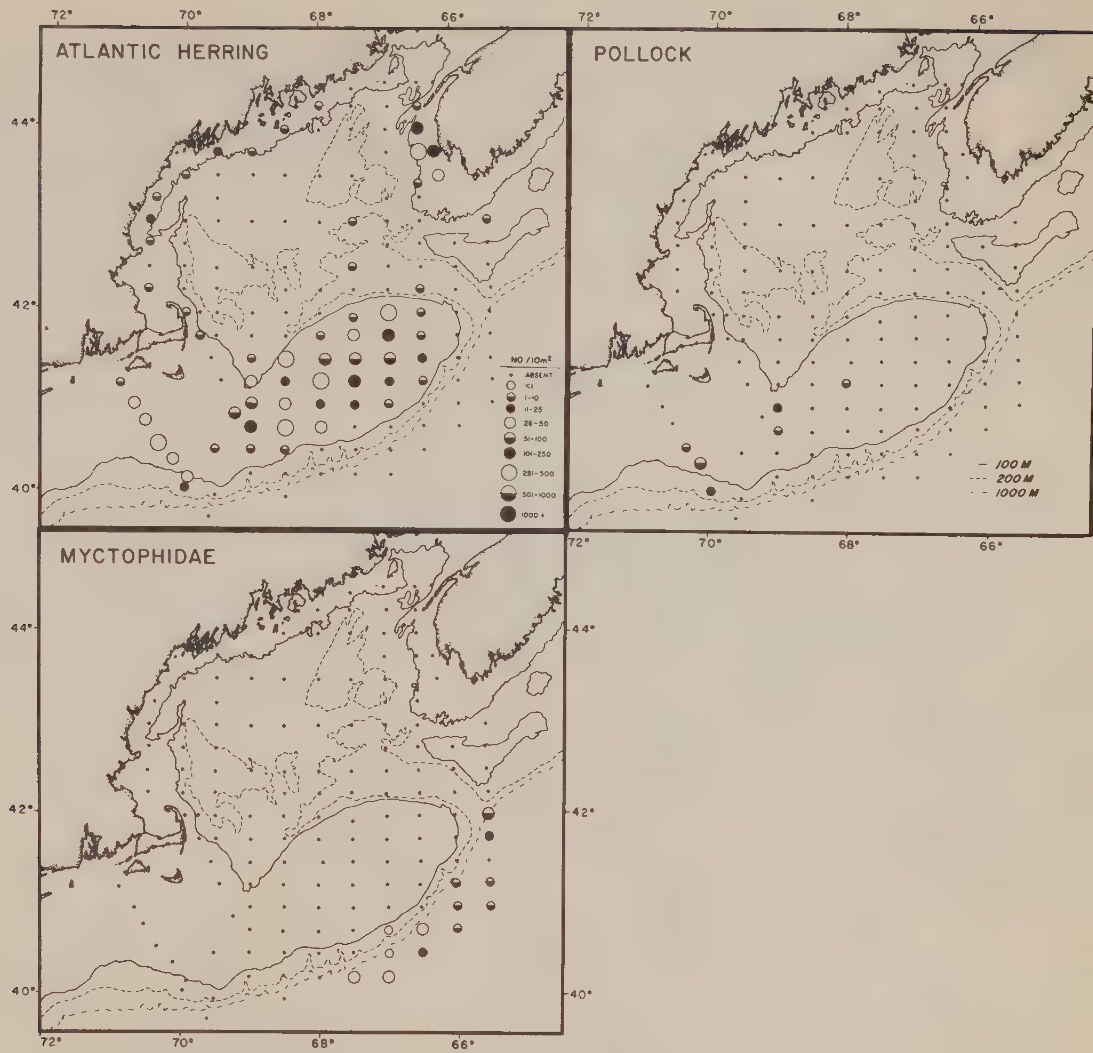
Figure 1.—Continued.


ATLANTIC HERRING
POLLOCK
MYCTOPHIDAE
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51-100
101-250
251-500
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— 100 M
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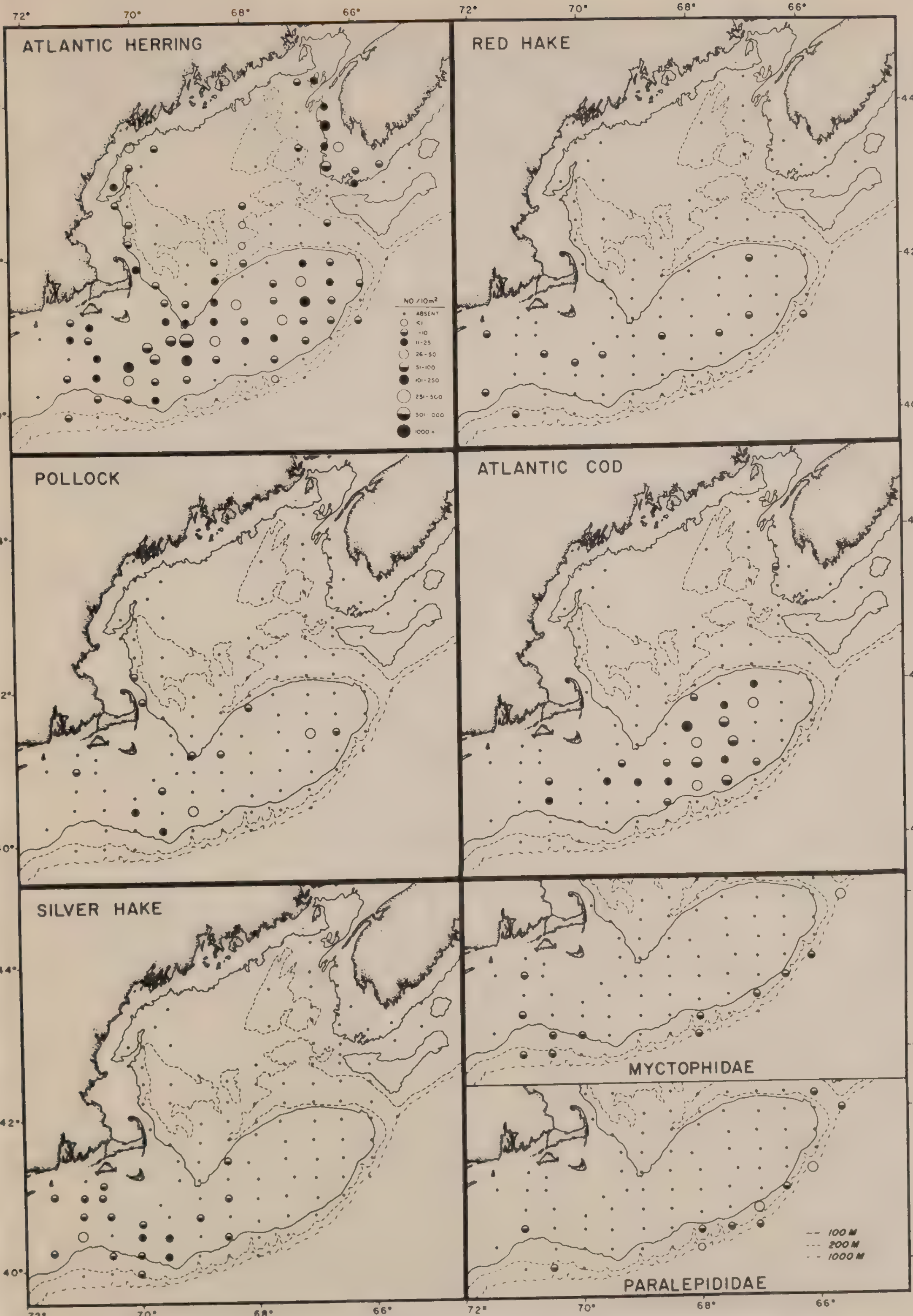
Figure 2.—Larval fish distribution, *Albatross IV* Cruise 71-7, 3-17 December 1971.



72°
70°
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66°
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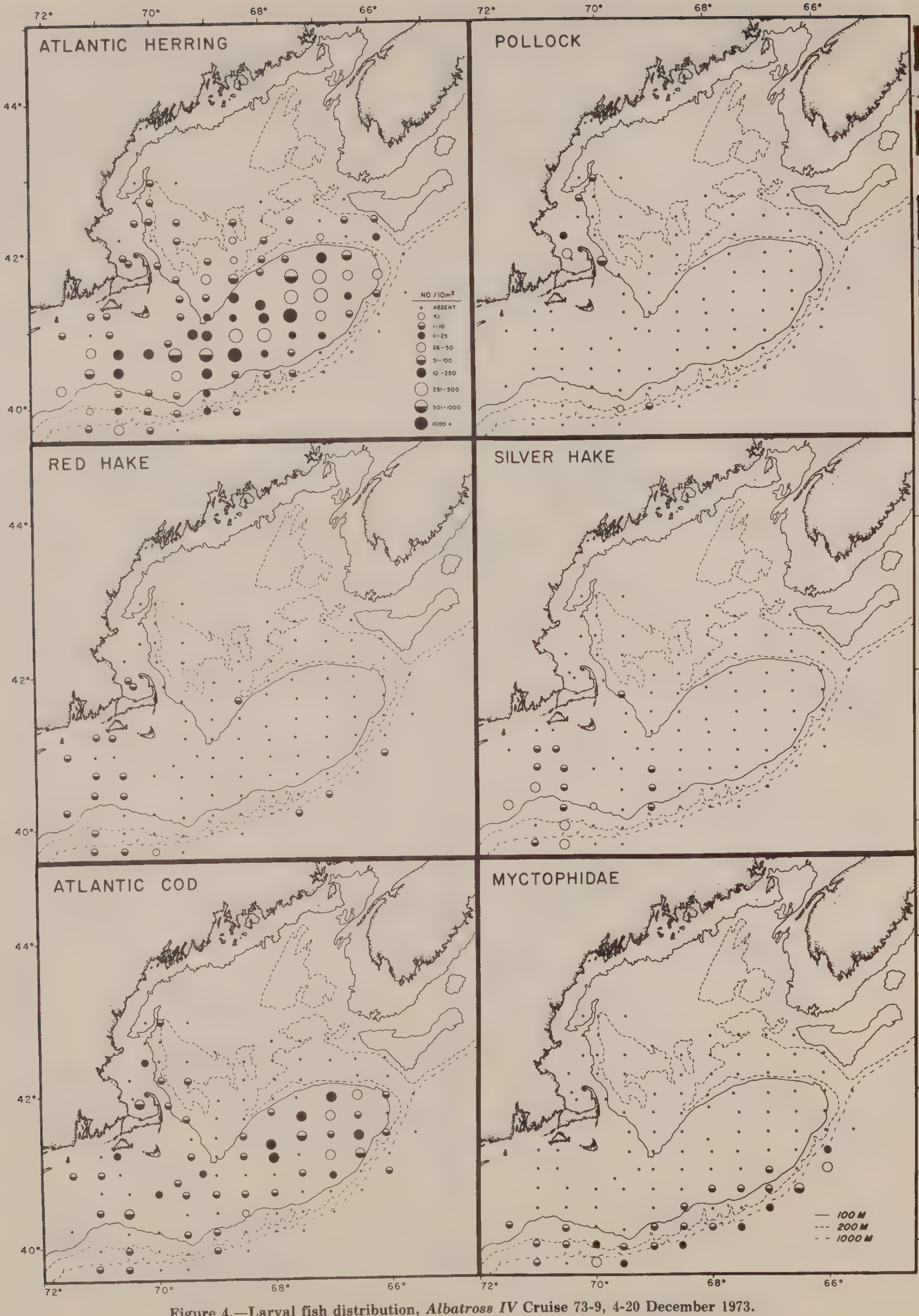
42°
40°
ATLANTIC HERRING
RED HAKE
POLLOCK
ATLANTIC COD
SILVER HAKE
MYCTOPHIDAE
PARALEPIDIDAE
NO /10m²
ABSENT
<1
-10
11-25
26-50
51-100
101-250
251-500
501 000
1000 +
100 M
200 M
1000 M

Figure 3.—Larval fish distribution, *Albatross IV* Cruise 72-9, 28 November-15 December 1972.



ATLANTIC HERRING
POLLOCK
RED HAKE
SILVER HAKE
ATLANTIC COD
MYCTOPHIDAE
72°
70°
68°
66°
44°
42°
40°
NO /10m²
• ABSENT
○ <1
1-10
● 11-25
○ 26-50
51-100
● 10 -250
○ 251-500
301-1000
● 1000 +
— 100 M
--- 200 M
- - 1000 M

Figure 4.—Larval fish distribution, *Albatross IV* Cruise 73-9, 4-20 December 1973.

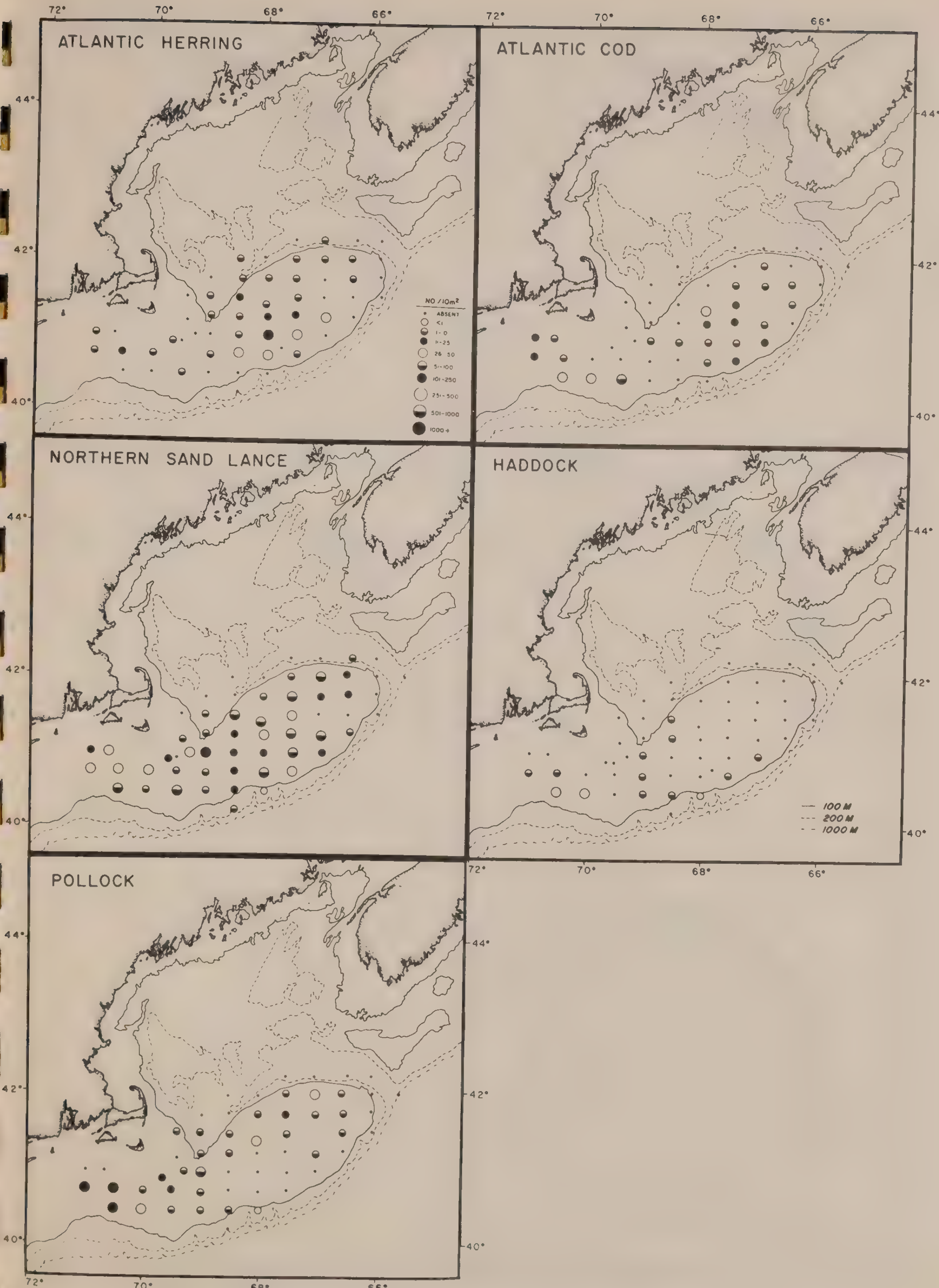

ATLANTIC HERRING
ATLANTIC COD
NORTHERN SAND LANCE
HADDOCK
POLLOCK
72°
70°
68°
66°
44°
42°
40°
NO /10m²
ABSENT
<1
1-10
11-25
26-50
51-100
101-250
251-500
501-1000
1000+
100 M
200 M
1000 M

Figure 5.—Larval fish distribution, *Albatross IV* Cruise 74-2, 11-22 February 1974.

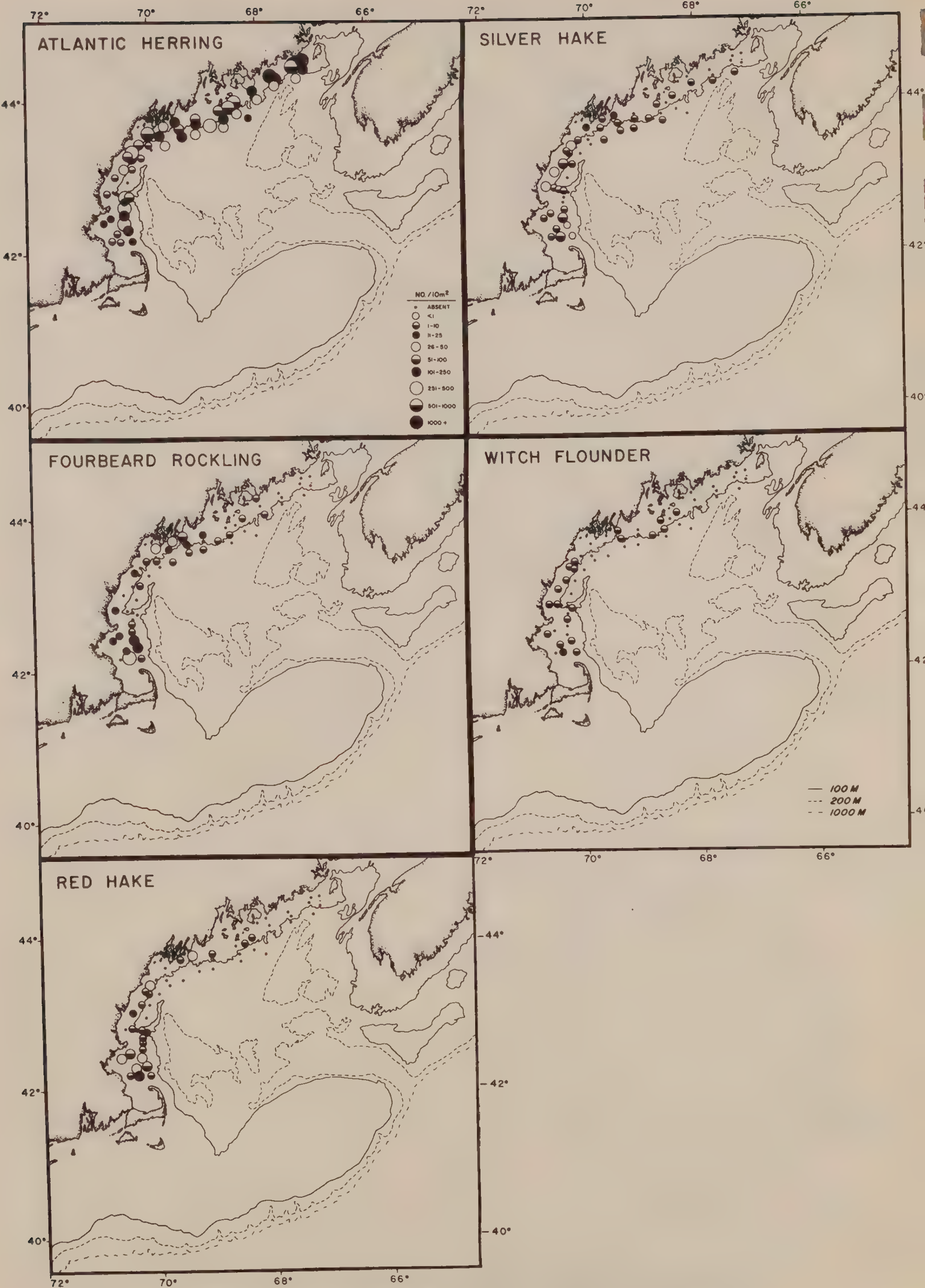
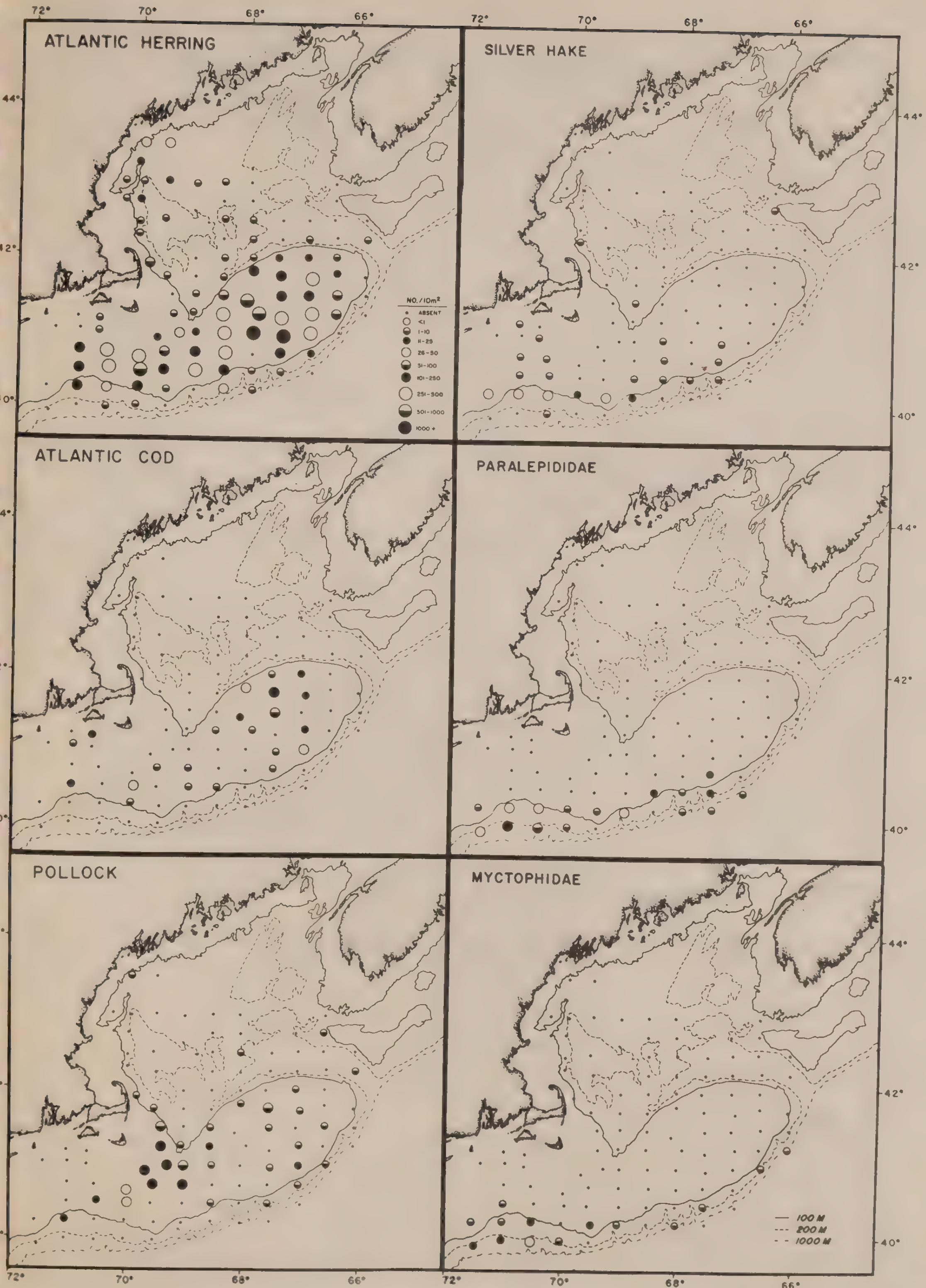

ATLANTIC HERRING
SILVER HAKE
FOURBEARD ROCKLING
WITCH FLOUNDER
RED HAKE
72°
70°
68°
66°
44°
42°
40°
NO./10m²
• ABSENT
<1
1-10
11-25
26-50
51-100
101-250
251-500
501-1000
1000+
100 M
200 M
1000 M

Figure 6.—Larval fish distribution, *Delaware II* Cruise 74-12, 8-12 October 1974.



72°
70°
68°
66°
ATLANTIC HERRING
SILVER HAKE
44°
42°
40°
NO./10m²
• ABSENT
○ <1
1-10
11-25
26-50
51-100
101-250
251-500
501-1000
1000+
ATLANTIC COD
PARALEPIDIDAE
POLLOCK
MYCTOPHIDAE
100 M
200 M
1000 M

Figure 7.—Larval fish distribution, *Albatross IV* Cruise 74-13, 4-18 December 1974.

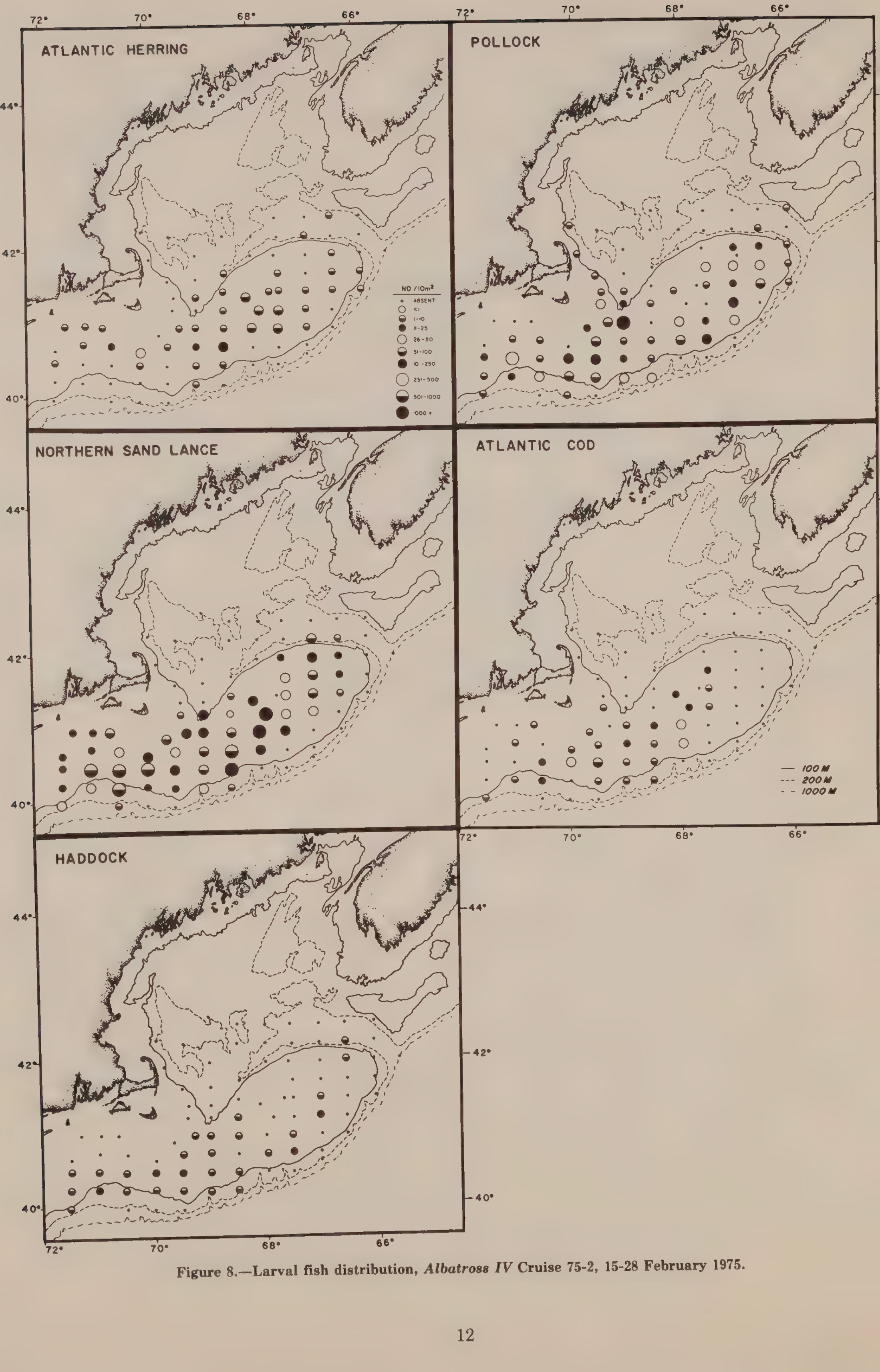
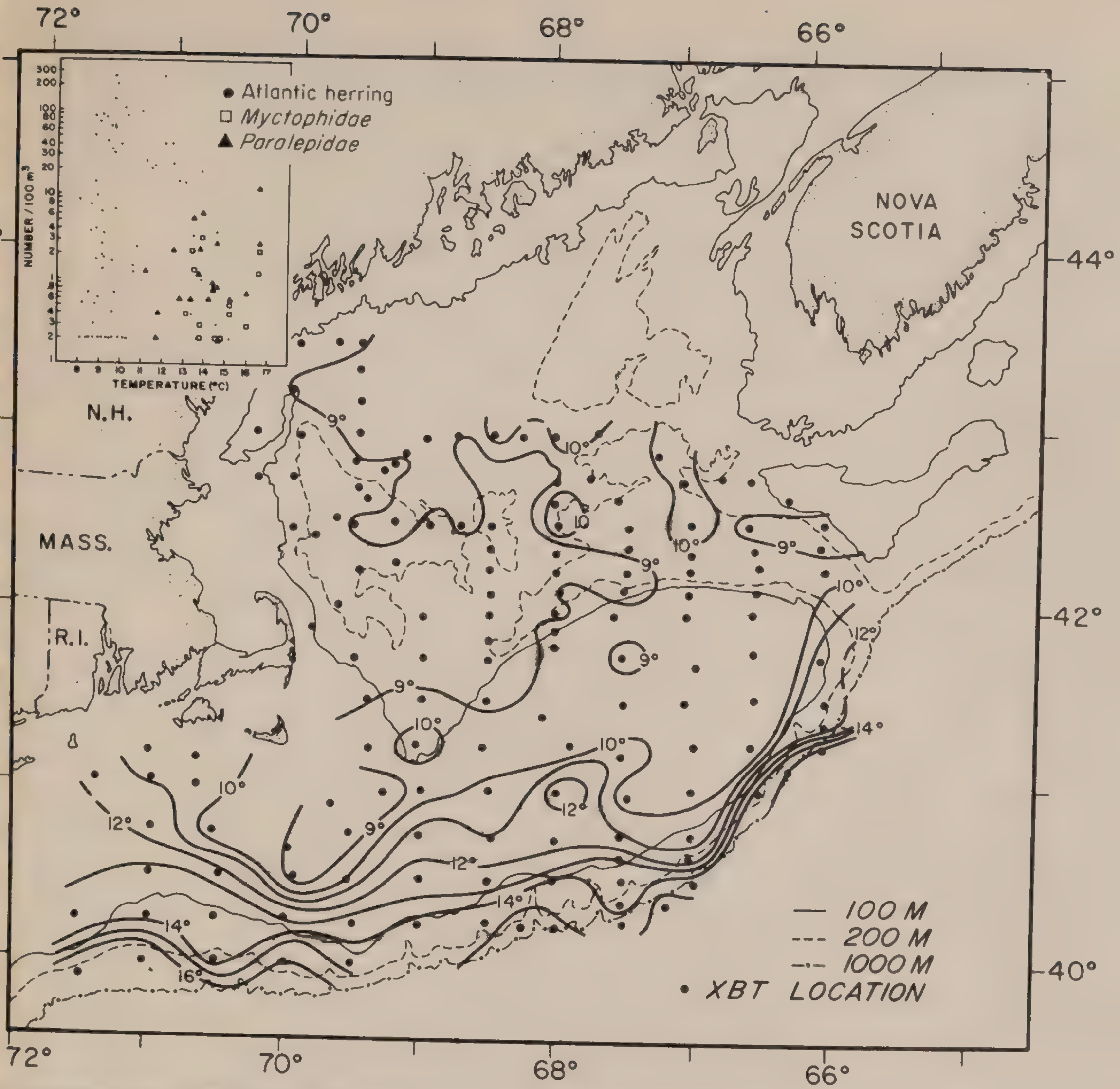

ATLANTIC HERRING
POLLOCK
NORTHERN SAND LANCE
ATLANTIC COD
HADDOCK
NO /10m²
ABSENT
<1
1-10
11-25
26-50
51-100
10 -250
251-500
501-1000
1000 +
100 M
200 M
1000 M
72°
70°
68°
66°
44°
42°
40°

Figure 8.—Larval fish distribution, *Albatross IV* Cruise 75-2, 15-28 February 1975.


72°
70°
68°
66°
● Atlantic herring
□ Myctophidae
▲ Paralepidae
NUMBER / 100 m3
TEMPERATURE (°C)
N.H.
MASS.
R.I.
NOVA SCOTIA
44°
42°
40°
9°
10°
12°
14°
16°
— 100 M
--- 200 M
-·- 1000 M
• XBT LOCATION

ure 9.—Distribution of upper 100-m integrated temperatures and their relationship to the distribution of Atlantic herring, Myctophidae, and Paralepididae larvae, *Albatross IV* Cruise 74-13.

TABLE 1.– Synopsis of families, genera a

	Del.II 71-4	Alb.IV 71-7	Alb.IV 72-9	Alb.IV 73-9	Alb.IV 74-2	Del.II 74-12	Alb.IV 74-13
ELOPIDAE[1]	X	X	-	-	-	-	-
Elops saurus	-	-	-	X	-	-	X
ANGUILLIDAE	-	X	X	X	-	-	X
Anguilla rostrata	-	-	-	-	-	-	X
MORINGUIDAE	X	-	-	X	-	-	-
MURAENIDAE	X	X	-	-	-	-	-
NETTASTOMATIDAE	X	-	-	X	-	-	-
NESSORHAMPHIDAE	-	-	-	-	-	-	-
CONGRIDAE	X	X	-	X	-	-	X
OPHICHTHIDAE	X	-	-	X	-	-	X
NEMICHTHYIDAE	-	X	-	-	-	-	-
NOTOCANTHIFORMES	-	-	-	-	-	-	X
CLUPEIDAE	X	X	-	X	-	X	-
Clupea harengus harengus	X	X	X	X	X	X	X
ENGRAULIDAE	X	-	-	-	-	-	X
GONOSTOMATIDAE	X	X	X	X	X	-	X
Cyclothone sp.	-	-	-	-	-	-	X
Gonostoma elongatum	-	-	-	-	-	-	X
Gonostoma sp.	-	-	-	-	-	-	X
Maurolicus muelleri	-	-	-	-	-	X	X
Vinciguerria nimbaria	-	-	-	-	-	-	X
CHAULIODONTIDAE	-	X	-	-	-	-	-
STOMIATIDAE	-	X	X	X	-	-	-
SYNODONTIDAE	X	-	X	X	-	-	X
Synodus sp.	-	-	X	-	-	-	-
PARALEPIDIDAE	X	X	X	X	X	-	X
Notolepis rissoi	-	-	-	-	-	-	X
Paralepis coregonoides	-	-	-	-	-	-	X
SCOPELARCHIDAE	-	-	-	-	-	-	X
NOTOSUDIDAE	-	X	-	X	-	-	X
MYCTOPHIDAE	X	X	X	X	-	-	X
Ceratoscopelus maderensis	-	-	-	-	-	-	X
Ceratoscopelus sp.	-	-	-	-	-	-	X
Diaphus dumerili	-	-	-	-	-	-	X
Myctophum sp.	-	-	-	-	-	-	X
LOPHIIDAE	X	-	-	-	-	-	-
Lophius americanus	X	-	-	-	-	-	-
ANTENNARIIDAE	-	-	-	X	-	-	X
OGCOCEPHALIDAE	X	-	-	-	-	-	-
CERATIIDAE	X	-	-	-	-	-	-
BREGMACEROTIDAE	-	X	-	X	-	-	X
Bregmaceros sp.	-	-	-	-	-	-	X
GADIDAE	X	-	X	X	X	-	X
Gadus morhua	-	X	X	X	X	-	X
Melanogrammus aeglefinus	X	-	-	-	X	-	-
Pollachius virens	-	X	X	X	X	X	X
Rhinonemus cimbrius	X	X	X	-	-	X	X
Urophycis chuss	X	X	X	X	-	X	X
Urophycis regius	X	-	-	X	-	-	-
Urophycis sp.	-	-	-	-	-	-	X
MERLUCCIDAE	-	X	X	X	-	X	-
Merluccius albidus	-	-	X	-	-	-	-
Merluccius bilinearis	X	X	X	X	-	X	X
Merluccius sp.	-	-	-	-	-	-	X
OPHIDIIDAE	X	X	-	X	-	-	X
CARAPIDAE	X	X	-	X	-	-	-
ZOARCIDAE	-	-	-	-	-	-	-
Macrozoarces americanus	-	-	-	-	-	-	-
MACROURIDAE	X	X	-	X	X	-	X
SCOMBERESOCIDAE	-	-	-	-	-	-	-
Scomberesox saurus	-	-	X	-	-	-	-
MELAMPHAEIDAE	-	-	-	X	-	-	-
GASTEROSTEIDAE	X	X	-	-	-	-	-
SYNGNATHIDAE	X	-	-	X	-	-	X
SCORPAENIDAE	X	X	-	-	-	-	X
Sebastes sp.	X	-	-	-	-	-	-
TRIGLIDAE	X	X	-	-	-	-	-
COTTIDAE	X	-	-	-	X	-	-
Myoxocephalus octodecemspinosus	-	-	-	-	X	-	-

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[1] Families are indicated as being present only when all specimens could not be identified to a lower taxonomic level.

species collected on larval herring surveys.

	Del.II 71-4	Alb.IV 71-7	Alb.IV 72-9	Alb.IV 73-9	Alb.IV 74-2	Del.II 74-12	Alb.IV 74-13	Alb 75
CYCLOPTERIDAE	X	-	-	-	-	-	X	
Cyclopterus lumpus	X	-	-	-	-	-	-	
Liparis inquilinus	-	-	-	-	X	X	-	
Liparis sp.	-	-	X	X	-	-	-	
SERRANIDAE	X	-	-	X	-	-	X	
APOGONIDAE	X	X	-	-	-	-	X	
CARANGIDAE	X	-	-	-	-	-	-	
GERRIDAE	X	-	-	-	-	-	-	
SPARIDAE	X	-	-	-	-	-	-	
SCIAENIDAE	X	-	-	-	-	-	X	
POMACENTRIDAE	-	-	-	-	-	-	X	-
MUGILIDAE	-	-	-	X	-	-	-	-
SPHYRAENIDAE	-	-	-	-	-	-	-	-
Sphyraena borealis	X	-	-	-	-	-	-	-
LABRIDAE	X	X	X	X	-	-	X	-
Tautoga onitis	-	-	-	-	-	X	-	-
Tautogolabrus adspersus	X	-	-	-	-	-	-	-
SCARIDAE	-	-	-	X	-	-	X	-
BLENNIIDAE	-	-	-	X	-	-	-	-
STICHAEIDAE	-	-	-	-	-	-	-	-
Crytacanthodes maculatus	-	-	-	-	X	-	-	-
Ulvaria subbifurcata	X	-	-	-	-	-	-	-
PHOLIDIDAE	-	-	-	-	-	-	-	-
Pholis gunnellus	X	-	-	-	X	X	-	X
AMMODYTIDAE	-	-	-	-	-	-	-	-
Ammodytes americanus	X	-	-	-	-	-	-	-
Ammodytes dubius	-	-	-	-	X	-	-	X
Ammodytes sp.	-	-	-	-	-	-	X	-
CALLIONYMIDAE	-	-	-	-	-	-	X	-
Callionymus sp.	-	-	-	X	-	-	X	-
GOBIIDAE	X	X	X	-	X	-	X	-
GEMPYLIDAE	-	X	-	X	-	-	-	-
NOMEIDAE	-	-	-	X	-	-	-	-
STROMATEIDAE	-	-	-	-	-	-	-	-
Peprilus alepidotus	X	-	-	-	-	-	-	-
Peprilus triacanthus	X	-	-	-	-	-	-	-
SCOPHTHALMIDAE	-	-	-	X	-	-	-	-
Scophthalmus aquosus	X	-	X	X	-	X	X	-
BOTHIDAE	X	X	-	X	-	X	X	-
Bothus ocellatus	X	X	X	X	-	-	-	-
Bothus sp.	X	-	-	X	-	-	X	-
Citharichthys arctifrons	X	-	-	X	-	-	X	-
Citharichthys sp.	X	-	-	-	-	-	X	-
Cyclopsetta fimbriata	X	-	-	-	-	-	-	-
Cyclopsetta sp.	X	-	-	X	-	-	-	-
Etropus microstomus	X	-	-	-	-	-	-	-
Etropus sp.	-	X	-	-	-	-	-	-
Hippoglossina oblonga	X	-	X	-	-	-	X	-
Monolene sp.	-	-	-	X	-	-	-	-
Paralichthys dentatus	-	-	-	X	-	X	X	X
Paralichthys oblongus	X	-	-	-	-	-	-	-
Syacium sp.	-	-	X	X	-	-	-	-
PLEURONECTIDAE	X	-	-	-	X	X	-	-
Glyptocephalus cynoglossus	X	-	-	-	-	X	-	-
Hippoglossoides platessoides	-	-	-	-	-	-	-	X
Limanda ferruginea	-	-	-	-	-	X	X	-
Poecilopsetta sp.	-	-	-	-	-	-	X	-
Scophthalmus aquosus	-	-	-	-	-	X	-	-
CYNOGLOSSIDAE	X	-	-	-	-	-	-	-
Symphurus sp.	X	-	-	-	-	-	X	-
BALISTIDAE	X	-	-	-	-	-	-	-
TETRAODONTIDAE	X	-	-	X	-	-	-	-

Table 2. Relative abundance of larval fishes collected

Delaware II 71-4					Albatross IV 72-9				
Taxon	Average Rank[1]	Dominance[2]	Abundance[3]	Frequency[4]	Taxon	Average Rank	Dominance	Abundance	Frequency
Silver hake	5.62	44/122	0.1-384.8 (192.4)	72/122	Atlantic herring	6.12	54/127	0.1-107.2 (53.6)	73/127
Red hake	4.96	17/122	0.1-247.2 (123.6)	59/122	Atlantic cod	4.02	11/127	0.2-35.5 (17.8)	22/127
Atlantic herring	3.74	17/122	0.1-625.3 (312.7)	29/122	Silver hake	3.84	7/127	0.2-5.1 (2.6)	19/127
Windowpane	3.65	1/122	0.1-54.9 (27.5)	33/122	Paralepididae	3.54	7/127	0.1-4.5 (2.3)	11/127
Myctophidae	3.46	10/122	0.1-112.9 (56.5)	22/122	Myctophidae	3.53	3/127	0.2-3.9 (1.5)	12/127
Butterfish	3.36	1/122	0.1-11.9 (6.0)	25/122	Pollock	3.53	4/127	0.3-7.6 (3.8)	12/127
Gulf Stream flounder	3.21	0	0.1-54.7 (27.4)	20/122	Red hake	3.43	0	0.1-0.9 (0.4)	11/127
Albatross IV 71-7					**Albatross IV 73-9**				
Atlantic herring	2.70	58/148	0.1-76.5 (38.3)	59/148	Atlantic herring	5.34	57/113	0.1-338.4 (169.2)	81/113
Myctophidae	1.75	14/148	0.1-4.4 (2.2)	14/148	Atlantic cod	3.89	14/113	0.1-45.5 (22.8)	45/113
Pollock	1.55	1/148	0.8-10.5 (5.6)	5/148	Myctophidae	3.11	11/113	0.1-10.0 (5.0)	19/113
					Silver hake	3.02	4/113	0.1-6.7 (3.4)	15/113
					Red hake	2.91	0	0.1-2.9 (1.5)	16/113
					Pollock	2.73	4/113	0.1-10.4 (5.2)	7/113

[1] Taxa were ranked within each sample on a basis of numbers of individuals. Ranks for each species were averaged over the total samples.

[2] Proportion of samples in which taxon was among those making up 50% of the individuals.

[3] Range and median (in parentheses) of number of individuals per 100 m^3 in samples in which taxon was found.

[4] Proportion of total samples in which taxon was found.